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Volume 18, Number 19, October 15, 1964

NUCLEAR SCIENCE ABSTRACTS

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TABLE OF CONTENTS

Volume 18, Number 19, October 15, 1964

Category	*Page*
BIOLOGY AND MEDICINE	4449
General	4449
Ecology	4451
Metabolism, Tissue Distribution, and Toxicology	4452
Radiation Effects	4458
Radiation Effects Therapy and Countermeasures	4479
Radiation Hazards and Protection	4481
Radiotherapy and Radiodiagnosis	4483
CHEMISTRY	4487
General	4487
Analytical Procedures	4488
Inorganic and Physical Chemistry	4495
Organic Chemistry	4508
Radiation Chemistry and Radiochemistry	4508
Separation Processes and Procedures	4517
ENGINEERING	4520
General	4520
Applications of Nuclear Explosions	4522
Facilities and Equipment	4522
Heat Transfer and Fluid Flow	4524
Materials Testing	4528
Protective Structures	4528
Vacuum Engineering	4528
GEOLOGY AND MINERALOGY	4530
General	4530
Natural Radioactivity and Fallout	4530
Site Survey and Selection	4532
Techniques and Equipment	4532
Thorium and Uranium Minerals	4534
HEALTH AND SAFETY	4536
INSTRUMENTATION	4540
General	4540
Radiation Detection	4546
ISOTOPE TECHNOLOGY	4560
General	4560
Industrial Applications	4560
Power Application	4562
Separation and Production	4562
MATHEMATICS AND COMPUTERS	4565
METALS, CERAMICS, AND OTHER MATERIALS	4566
General	4566
Corrosion	4572
Fabrication	4574
Properties and Structure	4579
Radiation Effects	4592
METEOROLOGY	4598
PHYSICS	4599
General	4599
Accelerators	4612
Astrophysics and Cosmology	4614
Atomic Physics	4617
Cosmic Radiation	4624
Criticality Studies	4627
Direct Energy Conversion	4628
Elementary Particles and Radiations	4629
Field Theory and Quantum Mechanics	4641
Geophysics	4644
Low Temperature Physics	4646
Neutron Physics	4651
Nuclear Properties and Reactions	4654
Plasma Physics and Thermonuclear Processes	4680
Shielding	4690
REACTOR TECHNOLOGY	4692
General	4692
Auxiliaries and Components	4695
Criticality Studies	4697
Design and Feasibility	4698
Fuels	4699
Power and Power-Breeder Reactors	4701
Production Reactors	4707
Propulsion and Space	4707
Research and Test Reactors	4710
WASTE DISPOSAL AND PROCESSING	4713
GENERAL AND MISCELLANEOUS	4715
CORPORATE AUTHOR INDEX	INDEX-1
PERSONAL AUTHOR INDEX	INDEX-9
SUBJECT INDEX	INDEX-47
REPORT NUMBER INDEX	INDEX-129

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Volume 18, Number 19 October 15, 1964

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

33211 (ACRH-21) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Leon O. Jacobson, Ed. (Argonne Cancer Research Hospital, Chicago). Mar. 1964. Contract AT(11-1)-69. 161p.

Separate abstracts were prepared for nine sections of the report. Three sections were previously abstracted and appeared in NSA Vol. 18 as Nos. 60 and 6730 and in RDA Vol. 8 as No. 103. (C.H.)

For abstracts of individual sections see: 33222, 33224, 33242, 33243, 33244, 33245, 33246, 33247, and 33817.

33212 (NYO-2570-1) BIOSYNTHESIS OF PROTEINS BY LIVING CELLS AND CELL FRACTIONS. Final Report, March 1, 1963–June 30, 1964. F. G. Sherman (Syracuse Univ., N. Y.). July 15, 1964. Contract AT(30-1)-2570. 50p.

The effects of 5-BrUdR on the RNA, DNA, and protein synthesis were studied. Results are reported from investigations of the maximum incorporation of 5-BrUdR into DNA, and the effects of 5-BrUdR on the base ratios of DNA; the incorporation of ^{14}C valine into TCA precipitable protein by cell free extracts; the fractionation of soluble proteins by DEAE-sephadex column chromatography; the characterization of 6-amino pyrimidine deaminase; unbalanced growth by thymineless and uracil-less mutants of E. coli; and the relation of iodine metabolism and protein synthesis in the rat thyroid gland. (C.H.)

33213 (STI/DOC/10/28(p.79-103)) RADIOISOTOPE APPLICATIONS IN AGRICULTURE. (International Atomic Energy Agency, Vienna).

Methods and results are reported for studies on the use of radiation and radioisotopes in agriculture. Data are presented on the use of x radiation to induce beneficiai mutations in maize, wheat, barley, rye, beans, peas, soybeans, peanuts, vetch, and rice; tracer studies of lipid metabolism in sheep; an investigation of ways to increase the availability of soil P for plants; the use of ^{14}C-urea and ^{32}P-phosphate to investigate the practicality of the foliar application of fertilizer on rice grown on reclaimed tidal lands; and the use of ^{14}C-methionine as a tracer in studies of amino acid metabolism in the liver of rats. (C.H.)

33214 (STI/DOC/10-28(p.105-11)) RADIOISOTOPE APPLICATIONS IN MEDICINE. (International Atomic Energy Agency, Vienna).

(1). Experimental methods and results are reported from tracer studies of iron metabolism and erythrocyte life span in patients suffering from congenital hemolytic anemia, with special reference to thallassemia, or sickle cell anemia. (2). The use of radioisotope scanning in the diagnosis of liver diseases is discussed. Emphasis is placed on applications of radioisotope scanning of the liver in the diagnosis of parasitic infestation. (C.H.)

33215 (TID-20824) PROGRESS REPORT [ON STORAGE OF PLATELETS AND WHITE BLOOD CELLS], 1963–1964. (Children's Cancer Research Foundation, Boston). Contract AT(30-1)-1753. 67p.

Improved techniques were developed for the storage of human blood platelets and leukocytes in the frozen state without loss of their ability to circulate in vivo. The technique employs 5% dextrose and 5 to 10% dimethylsulfoxide as protecting agents during freezing and a strictly controlled rate of freezing. Results are reported for clinical studies on 36 thrombocytopenic patients infused with preserved platelets and studies on irradiated, leukopenic mice and rats given infusions of preserved leukocytes. Studies on platelet antigenic composition and platelet function were continued and preliminary results are reported. The effects of Escherichia coli bacterial endotoxin on platelets and coagulation were also investigated in irradiated rats. Pretreatment of animals with endotoxin resulted in a marked reduction of the ability to circulate transfused homologous platelets. Infusion with high molecular weight dextran was found capable of mobilizing white blood cells from tissue stores. (C.H.)

33216 REGENERATION OF BONE MARROW: A CLINICAL AND EXPERIMENTAL STUDY (PRELIMINARY REPORT). U. Breine, P. I. Branemark, and B. Johanson (Univ. of Gothenburg, Sweden). Acta Chir. Scand., 122: 125-30(1961).

Parameters of bone marrow regeneration were studied clinically and experimentally. The clinical series comprised infants aged ~7 months. At the initial operation, a sample of bone marrow was taken from the intact tissue and subsequently biopsy specimens of the regenerating tissue were taken at varying intervals. The experimental series comprised rabbits aged from 5 to 8 months. The medullary cavity of one tibia was evacuated mechanically. The animals were sacrificed after intervals ranging from one to 150 days, and samples were taken from the regenerating tissue; specimens were also collected from the intact tibital marrow on the other side for control pur-

poses. Pilot studies were also carried out in which windows were inserted into the tibia and femur of the rabbit to permit continuous observation on the course of regeneration with a direct vital microscopic technique. The course of regeneration in the experimental and clinical series corresponded both structurally and as regards the time factor. (TCO)

33217 THE CHROMOSOMAL DISEASES AND THE GLOBAL DISEASES. Tage Kemp (Univ. Inst. for Human Genetics, Copenhagen). Acta Genet. Statist. Med., 11: 196-204(1961).

On the basis of the experience gained and the observations made within recent years, two new groups or concepts of diseases are proposed: the chromosomal diseases and the global diseases. The chromosomal diseases are determined by deviations from the normal in the chromosomal conditions, demonstrable only by microscopy. During cell division the nucleus of the cell is split into a certain number of chromosomes. The number is constant within each species, but varies from one species to another, thus contributing towards characterizing the species. Accordingly, the concept of chromosomal diseases is not identical with that of hereditary diseases, the latter being far more comprehensive. The chromosomal diseases have certain features in common. Many of these patients have intelligence defects, or may even be characterized as proper mental defectives. Further, such patients often present physical deformities. Patients suffering from the chromosomal diseases often present abnormal development of their sexual character. The global diseases are such as may develop in consequence of the falling of radioactive substances produced by explosions, most often so far test explosion of atomic bombs and nuclear weapons. The radioactive fall-out descends on the globe from the stratosphere or even more distant spheres. It spreads over different parts of the globe. That is why the diseases have been called global. (auth)

33218 QUANTUM CONVERSION IN CHLOROPLASTS. Melvin Calvin (Univ. of California, Berkeley). Advan. Catalysis, 14: 1-34(1963).

A review is presented on a catalytic system for converting electromagnetic energy into chemical energy. The system itself, to a first approximation, remains unchanged and, therefore, fulfills the definition of a catalyst. Energy sources for photosynthesis, photochemistry of chlorophyll, photophysical effects in model systems, charge separation processes, relation to the photosynthetic apparatus, and quantum conversion in biological material are discussed. 74 references are included. (P.C.H.)

33219 PRIMARY RECONSTRUCTION OF CERVICAL ESOPHAGUS: USE OF THE FREE TRACHEAL GRAFT. Richard T. Farrior. Arch. Otolaryngol., 79: 258-68(Mar. 1964).

Development of a radiation-induced lesion over a period of 27 yr is described in a patient treated with x rays for cancer of the larynx. This case exemplifies the continuous, progressive changes following x-ray therapy, including the progressive fibrosis, increasing avascular fibrosis, and vascular occlusion. This case also exemplifies severe radiation dermatitis with atrophy of the skin to the point of ulceration and breakdown, telangiectasis in the skin, and apparent premalignant criteria. In the tissue reaction, radiation fibroblasts could be identified. Repair of radiation-induced lesions was effected by the use of a free tracheal composite graft. Despite some contracture requiring dilatation, the patient was repaired in a single stage procedure. (TCO)

33220 LIQUID SCINTILLATION COUNTING. Walter E. Kisieleski (Argonne National Lab., Ill.). Biochim. Appl., 11: 1-7(Jan.-Feb. 1964).

Some methods for operation and application of liquid scintillation counting for low-energy beta-emitting radioisotopes for biological and medical research are discussed. (L.B.S.)

33221 EVALUATION OF AN IMAGE INTENSIFIER SYSTEM FOR MICROSCOPIC OBSERVATIONS. Geo. T. Reynolds (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 147-51(June 1964).

Several image intensifiers were evaluated as possible aids in increasing the speed and/or sensitivity of low light-level microscopic observations, especially with polarized light. The maximum overall gain for microscopy, including light losses involved in photographing the phosphor screen output was 10^4 obtained with a TSE tube with a measured quantum gain of 9×10^5. Since the resolution at the phosphor screen is somewhat greater than 20 line pairs/mm, it is in principle possible to resolve distances of the order of 0.5 μ in the microscopic field at a microscope magnification of 100 X. Contrast provided by a bright object in a dark field is faithfully represented by the tube except for thermal and signal-generated background noise. However, the contrast of dark objects in a bright background tends to be spoiled by signal-generated noise from the brighter background. Experience gained to date indicates that as applied to microscopy, the image intensifier is most useful in recording events producing, transmitting or scattering limited numbers of photons and with low ambient light, such as bioluminescence of single cells and subcellular particles, high extinction polarization and interference microscopy and fluorescence microscopy. It should also be useful for reducing the total light energy to which the specimen must be exposed. The image intensifier was applied to microscopic observations of bioluminescence in Noctiluca miliaris. The luminescence appears to come from the surface of the cell, and structural sources of the order of 1-2 μ were followed with an oil immersion objective in successive bioluminescent flashes induced at 20 second intervals. The image intensifier was also applied to the photographic recording of weak radioactive sources. (auth)

33222 BIOLOGIC PROPERTIES OF POLYNUCLEOTIDES. I. THE ANTICOMPLEMENTARY ACTIVITY OF POLYNUCLEOTIDES. S. Yachnin. J. Clin. Invest., 42: 1947-?(1963). (ACRH-21(p.144-57))

During the course of studies on the potential antigenicity of homoribopolynucleotides in experimental animals, it was noted that polyinosinic acid (poly I) exhibited strong anticomplementary (Anti-C′) activity. This phenomenon is described in detail, and the quantitative as well as qualitative aspects of the poly I-complement (C′) interaction are discussed. Evidence is presented that will define some of the structural requirements necessary for the endowment of ribopolynucleotides in general with Anti-C′ properties. (C.H.)

33223 BONE MARROW ASPIRATION IN MICE. S. Vlahovic and J. W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Transplantation, 2: 545-7 (July 1964).

Bone marrow aspirated from the femur of mice was used to restore marrow function in the same mice after exposure to lethal doses of x radiation. The aspiration technique is described. (C.H.)

33224 CLINICAL SIGNIFICANCE OF PERCUTANEOUS ABSORPTION. S. Rothman. Triangle. Sandoz. J. Med. Sci., 6: No. 5, 1964. (ACRH-21(p.38-44))

Percutaneous absorption denotes the passage of substances from the outside through the entire thickness of the skin and into the circulation. The histological features of human skin are described with emphasis on the barrier membrane. Percutaneous absorption by the transepidermal and the transfollicular routes is described, and the clinical significance of percutaneous absorption is discussed. (C.H.)

33225 TUBERCULOSIS IN HIROSHIMA. R. W. Turner and D. R. Hollingsworth (Atomic Bomb Casualty Commission, Hiroshima). Yale J. Biol. Med., 36: 165-82(1963).

The prevalence of TB was determined in the Adult Health Study of the Atomic Bomb Casualty Commission in Hiroshima. In the 1958 to 1960 sample 16.8% of the men and 10.5% of the women were found to have TB on a retrospective review of the chest films and clinical records. Radiation exposure was not related to prevalence or radiologic extent of disease. Although it is quite possible that an increase in TB might have been present in the irradiated survivors of the immediate post-bomb period, no such trends are noted in the follow-up of the present survivors. Other factors investigated in this study included the prevalence of pleurisy, extra-pulmonary TB, and diabetes. Bacteriologic studies, chemotherapy, and occupational correlations were discussed briefly. (Excerpta Med., Sect. XXIII, 1: No. 6 (June 1964))

33226 ISOTOPIC MEASUREMENTS ON THE LIFE-CYCLE OF TISSUE CELLS. G. Hevesy (Univ. of Stockholm). p.34-44 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The life cycle of nondividing tissue cells can be determined by labeling the desoxyribonucleic acid of the cells in utero and measuring the rate of disappearance of the radioactive label with time. An alternative method is the measurement of the rate of incorporation of a radioactive label into the desoxyribonucleic acid of the cells to be investigated. The effect of different agents administered on the life cycle of cells and the connection between life cycle and detoxication going on in the organism are discussed. The diurnal variation of the life cycle of tissue cells and the agents responsible for these variations are discussed. (auth)

33227 ELEKTRONENSPINRESONANZ IN DER BIOLOGIE. (Electron Spin Resonance in Biology). G. Schoffa. Karlsruhe, Ger., Verlag G. Braun, 1964. 364p. DM 68.-.

The results of studies on electron spin resonance and magnetic susceptibility in the area of biology are compiled in book form for the first time. Part I deals with the theory of ESR, ESR and chemical bonding in metal complexes, measurement methods and problems, causes of ESR signals in plant and animal substances, biological metal complexes, ESR in biological ferment systems, melanine, radicals produced by oxygen effects, ESR in photosynthesis, ESR of biological systems after uv, γ, and x irradiation, abnormal resonance effects in nucleic acids, yeasts, and bacteriophages, effects of external influences on radioinduced free radicals, ESR studies on radiation protection, free radicals and carcinogenesis, and ESR of the triplet state. In Part II, on the static magnetic susceptibility in biology, the topics discussed are behavior of matter in magnetic fields, magnetic permeability, susceptibility, and moment, theory of paramagnetism, energy levels and magnetic susceptibility of ions of the iron group, paramagnetism of complexes, theory of diamagnetism, measurement methods of magnetic susceptibility, and results of magnetic susceptibility on biological metalporphyrins and other biological substances. (J.S.R.)

33228 BASES PHYSIQUES DE LA RADIOTHÉRAPIE ET DE LA RADIOBIOLOGIE. (Physical Basis of Radiotherapy and Radiobiology). Maurice Tubiana, Jean Dutreix, Andrée Dutreix, and Pierre Jockey. Paris, Masson et Cie, 1963. 820p. 140 F.

A review of the basic physical concepts of matter, energy, and radiations serves as an introduction to the subject of radiation dosimetry and the mode of action of radiation on living organisms. The book, addressed to radiobiologists and radiotherapists, is divided into four sections. The interactions between radiation and matter is the subject of the first section with a discussion of elementary electron interactions, photon interactions, interactions of other radiations, energy absorption by the medium, general laws of the photon beam, and secondary electrons. The second part concerns theoretical dosimetry and discusses units, measurement apparatus, and generators. Clinical dosimetry is considered in the third section. The particular subjects are the practical study of the beam, dose distribution in a medium irradiated by a beam, dose in the organism, and dosimetry of radioelements. In the fourth section, the chain of events from the elementary physical interactions to the ultimate medical and biological consequences is traced. The problems of protection are dealt with under the double aspects of the risks encountered by the irradiated organism and the precautions necessary. (J.S.R.)

33229 INTERNATIONAL REVIEW OF EXPERIMENTAL PATHOLOGY. VOLUME 2. G. W. Richter and M. A. Epstein, eds. New York, Academic Press, 1963. 455p. $16.00.

Important problems of experimental pathology are reviewed. Papers are presented on: the nucleic acids of viruses as revealed by their reactions with fluorochrome acridine orange; cytochemical aspects of experimental leukemia; a lymphoma syndrome in tropical Africa; the use of statistics in the etiological study of malignant neoplasms; biological effects of ionizing radiations; microscopic morphology of injured living tissue; cellular recognition of foreign matter; and melanin granules-their fine structure, formation, and degradation in normal and pathologic tissues. A separate abstract was prepared for the biological effects of ionizing radiation. (H.M.G.)

For abstract of individual paper see: 33397.

Ecology

33230 RADIOEKOLOGIYA MORSKIKH ORGANIZMOV. NAKOPLENIE, BIOLOGICHESKOE DEISTVIE RADIOAKTIVNYKH VESHCHESTV. (Radioecology of Marine Organisms. Accumulation and Biological Effects of Radioactive Materials). G. G. Polikarpov. Moscow, Atomizdat, 1964. 295p.

Data are given on the accumulation of radioactive isotopes (from eight chemical groups) in marine ecology. The uptake of fission-product isotopes by algae and aquatic organisms was evaluated, and the radioresistance of hydrobiota was estimated. An extensive list of references is included. (R.V.J.)

Metabolism, Tissue Distribution, and Toxicology

33231 (NIRS-2(p.49-56)) MEDICAL STUDIES. (Japan. National Inst. of Radiological Sciences, Tokyo).

Experiments on edema using the disappearance of $Na^{131}I$ and ^{131}I-labeled human albumin, chromosome aberration of irradiated persons, the enolase activity of human leukocytes in healthy subjects and leukemia patients, the use of ^{57}Co-labeled EDTA to increase scanning resolution and reduce radiation dose delivered to the kidney, the mode of erythropoietin action, and removal of ^{85}Sr deposited in the bone using parathyroid hormone are reported. (H.M.G.)

33232 (NYO-910-3) RADIATION STUDIES: METABOLIC STUDIES WITH CALCIUM-47 AND OTHER RADIOACTIVE ISOTOPES. Progress Report, May 1, 1963–May 1, 1964. John S. Laughlin (Sloan-Kettering Inst. for Cancer Research, New York). July 1, 1964. Contract AT(30-1)-910. 22p.

A high-energy x-ray scanner was used for whole-body scanning to measure the total-body retention of tracer doses of ^{47}Ca, ^{85}Sr, ^{131}I, and ^{59}Fe and for liver scanning of patients injected with ^{131}I-rose bengal. Mathematical analyses of the data were carried out, and results were compared with those obtained in carefully controlled excreta analyses. Liver scans were found to be diagnostically helpful and accurate in delineating liver abnormalities. Whole-body scanning was also used in conjunction with injected tracer doses of ^{85}Sr to study the effects of electron beam irradiation on bone metabolism in dogs and the localization of ^{131}I-labeled antibody in human tumors. A computer program was written and used in a number of test cases to predict the response patterns and sensitivity of NaI scintillation detectors. A digital data display system was designed to simultaneously record on punched paper tape data from 4 6-decade scalers as well as data regarding the distance and direction of movement of the scanner heads during the time the data accumulated. Design data and circuit diagrams are appended. A list is included of publications during the period covered by this report. (C.H.)

33233 (NYO-910-9) RADIATION STUDIES: STUDIES OF THE KINETIC STATE OF CALCIUM IN BONE LESIONS, USING CALCIUM-47 AND STRONTIUM-85. Progress Report, June 1, 1963–May 30, 1964. W. P. Laird Myers (Sloan-Kettering Inst. for Cancer Research, New York). July 1, 1964. Contract AT(30-1)-910. 9p.

The distribution and kinetics of tracer doses of ^{47}Ca and ^{85}Sr were followed by means of total-body γ scanning in 33 patients with cancer metastatic to bone, or who were suspected of having such metastases. Metastatic lesions were revealed in the absence of x-ray evidence. The method was also used to study the effect of radiation treatment on the retention of ^{47}Ca and ^{85}Sr by bone lesions. Kinetic studies with ^{47}Ca conducted simultaneously with analyses of blood and urine for content of injected tetracycline indicated that the tetracycline tolerance test may become a useful method for studying bone disease. (C.H.)

33234 (UCRL-11459) A VARIANT CYTOPHOTOMETRIC TECHNIQUE AND ITS APPLICATION TO THE STUDY OF ERYTHROPOIESIS THROUGH MEASUREMENT OF TOTAL DNA AND HEMOGLOBIN IN SINGLE ERYTHROID CELLS (thesis). Lawrence Richards Adams (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley. Donner Lab.). May 29, 1964. Contract W-7405-eng-48. 185p.

A photographic-photometric method for cytophotometry is described. The method was applied to the study of single-cell amounts of hemoglobin and Feulgen-stained DNA in rat erythrocyte precursors and erythrocytes. The data so obtained allow plotting a novel cytophotometric hemogram. Comparison of the hemograms, and other experimental parameters, for normal and severely bled rats suggests that the stimulus of severe bleeding causes the premature release from the marrow of erythrocyte precursors. This finding is discussed in context with recent findings and models of erythropoietic development reported in the literature of experimental hematology. (156 references.) (auth)

33235 (AEC-tr-6448) ON THE CONTAMINATION OF VEGETATION BY STRONTIUM-90 AND CESIUM-137 IN 1961. V. P. Shvedov, S. P. Rosyanov, and Z. G. Gritchenko. Translated from a Russian Report, State Committee on the Peaceful Uses of Atomic Energy, SSSR, Moscow, 1963. 8p.

The strontium-90 and cesium-137 contents in mixed-grass vegetation were determined. It was shown that the accumulation coefficients for strontium-90 and cesium-137 by the aboveground portions of the plants are greater than 1, which indicates an ability of the plants to participate in processes of purification or the ground layer of air. (auth)

33236 (ANL-Trans-54) THE METABOLISM OF LIPIDIC PEROXIDES. II. ACTION OF LIPIDIC PEROXIDES ON PROTEIN THIOL GROUPS. P. Dubouloz and J. Fondarai. Translated by Rita R. Inston (Argonne National Lab., Ill.), from Bull. Soc. Chim. Biol., 35: 819-26 (1953). 13p.

The effects of lipidic peroxides on protein thiol groups were studied in lyophilized egg ovalbumin. The destruction of SH groups by peroxides was demonstrated. Reaction mechanisms involved are discussed. (C.H.)

33237 PHYSIOLOGICAL AND BIOCHEMICAL STUDIES ON NITROGEN-FIXING BLUE-GREEN ALGAE. II. THE ROLE OF CALCIUM, STRONTIUM, COBALT, AND MOLYBDENUM IN THE NITROGEN FIXATION OF NOSTOC COMMUNE. Ezz Eldin M. Taha and Ard El Monem H. Elrefai (National Research Center, Cairo). Arch. Mikrobiol., 43: 67-75(1962).

While Ca showed a marked stimulatory action on both growth and nitrogen fixation processes in Nostoc commune, Sr in equivalent amounts proved to have a strong inhibitory action on both processes. Thus, Ca was found to be irreplaceable by divalent ions as represented by Sr. Cobalt and Mo (in traces) were also found to be required to support best growth and optimal nitrogen fixation. Amounts as low as 4×10^{-5} mg/l Co and 4×10^{-3} mg/l Mo were found to be required for the achievement of best growth and highest nitrogen fixation. Algal yields and nitrogen fixed at this optimal Co level were more than that of the control to which no Co was added by about 58%. With Mo the increase in algal yield and nitrogen fixed accompanying the addition of the optimal level of Mo was 51.5% of that of the control. (BBB)

33238 THE KINETICS OF ^{42}K DISTRIBUTION AFTER INTRAVENOUS ADMINISTRATION IN HUMAN SUBJECTS WITH PARTICULAR REFERENCE TO THE KIDNEY. Arthur G. Goldman, A. Aaron Yalow, and Jacob Grossman (Montefiore Hospital, New York). Clin. Sci., 24: 287-99 (Apr. 1963).

In nine patients injected intravenously with 100 to 150 μC

of high specific activity ^{42}KCl; the kinetics of the ^{42}K distribution was studied from analyses of urinary, arterial, and venous plasma specific activity and arterial plasma ^{42}K concentration for periods up to four hr after injection. The time course of isotope concentration in arterial plasma appeared to be unrelated to plasma ^{39}K levels. It is presumably dependent on the rate of transfer of ^{42}K from high-activity visceral depots, established during the phase of initial ^{42}K deposition, into the ultimate muscle depots. The forearm arteriovenous difference of ^{42}K specific activity correlated with the concurrently observed forearm arteriovenous oxygen difference, and appeared to be related to the cellularity of the tissues drained by the venous sampling site. Urinary specific activity was consistently lower on high K intake than at comparable times during K depletion, reflecting the more rapid washout of the renal depot of ^{42}K by the higher potassium flow during repletion. For several minutes after injection of ^{42}K, the urinary specific activity was more than double that expected on the basis of current concepts of ^{42}K distribution and renal K content. This finding indicates inhomogeneous mixing of ^{42}K with renal ^{39}K during its passage from arterial plasma into urine. Possible explanations of the inhomogeneity are discussed. (TCO)

33239 EXPERIMENTAL STUDY OF THE RADIOACTIVE CONTAMINATION OF CULTURES, ESPECIALLY BY IRRIGATION WATER. Francis Perrin. Compt. Rend. Acad. Agr. France, 49: 611-20([1963]). (In French)

The relation between the rate of contamination of the natural milieu and that of plants was defined in order to determine if the rate of soil contamination would remain slow so that the threshold of toxicity would never be reached in foodstuffs. ^{90}Sr or ^{137}Cs was applied in solution in relatively high doses to soils of various types, and the fraction of radioactivity of each element in different cultivated plants was determined. Ratios were determined for the radioelement in 1 kg of harvested food/radioelement in 1 m^3 of soil and for the radioelement in 1 kg of harvested food/radioelement in 1 liter of irrigation water. The results obtained for grapes, fescue, and vegetables were tabulated and discussed. They indicate that the maximum permissible concentration should be higher for irrigation water than for drinking water. (J.S.R.)

33240 DISTRIBUTION AND SOLUBILITY OF STRONTIUM-90 IN BONES OF ANIMALS. H. Seidler. Ernaehrungsforschung, 8: 417-22(1963). (In German)

The distribution and solubility of ^{90}Sr in cattle, swine, and sheep bones are reported. Variations between species and types of bones were found contrary to data reported in the literature. In the investigation of the solubility of the ^{90}Sr absorbed from the bones, it was established that considerable ^{90}Sr activity was extractable with water. (tr-auth)

33241 INFLUENCE OF CALCIUM, POTASSIUM, AND SODIUM COMPOUNDS ON THE ACCUMULATION OF STRONTIUM-90 IN CROPS. E. V. Yudintseva. Izv. Timiryazev. Sel'shokhoz. Akad., No. 5, 106-20(1963). (In Russian)

Introduction of carbonate, sulfate, phosphate, and calcium hydroxide into acid soil reduced the concentration of ^{90}Sr in barley and pea crops. In weakly acid soils, ^{90}Sr uptake was not changed. Potassium and sodium compounds reduced ^{90}Sr concentrations in crops in both acid and weakly acid soils. They also reduced uptake of ^{90}Sr from aqueous solutions. (R.V.J.)

33242 THE EFFECT OF ERYTHROPOIETIN UPON HEME SYNTHESIS BY MARROW CELLS IN VITRO. S. B. Krantz, O. Gallien-Lartigue, and E. Goldwasser (Collège de France, Paris). J. Biol. Chem., 238: 4085-?(1963). (ACRH-21(p.1-9))

A cell culture method is described that was developed for use as an in vitro system for use in studies of the effects of erythropoietin on heme synthesis by bone marrow cells. Results are reported from studies using ^{59}Fe as a tracer. The advantages of the system in chemical studies of cell differentiation are discussed. (C.H.)

33243 ENZYMATIC SYNTHESIS OF RIBONUCLEIC ACID. I. PREPARATION OF RNA POLYMERASE FROM EXTRACTS OF M. LYSODEIKTICUS. T. Nakamoto (Rockefeller Institute, New York); C. F. Fox, and S. B. Weiss. J. Biol. Chem., 239: 167-?(1964). (ACRH-21(p.72-86))

Methods are described for the preparation and purification of RNA polymerase from M. lysodeikticus. (C.H.)

33244 ENZYMATIC SYNTHESIS OF RIBONUCLEIC ACID. II. PROPERTIES OF THE DNA PRIMED REACTION WITH M. LYSODEIKTICUS RNA POLYMERASE. C. F. Fox and S. B. Weiss. J. Biol. Chem., 239: 174-?(1964). (ACRH-21(p.87-110))

M. lysodeikticus RNA polymerase was shown to catalyze at least two separate DNA-dependent reactions. One reaction resulted in the synthesis of complementary RNA and the other gave rise to an RNA homopolymer. Reaction mechanisms involved are discussed. (C.H.)

33245 ENZYMATIC SYNTHESIS OF RIBONUCLEIC ACID. III. THE RNA PRIMED SYNTHESIS OF RNA WITH M. LYSODEIKTICUS RNA POLYMERASE. C. F. Fox, W. S. Robinson, R. Haselkorn, and S. B. Weiss. J. Biol. Chem., 239: 186-?(1964). (ACRH-21(p.111-31))

Properties of the RNA-directed reaction catalyzed by partially purified preparations of RNA polymerase are described. Evidence is presented that suggests the involvement of only one enzyme. (C.H.)

33246 THE BIOSYNTHESIS OF 5-RIBOSYLURACIL-5'-MONOPHOSPHATE IN TETRAHYMENA PYRIFORMIS. R. L. Heinrikson and E. Goldwasser (Rockefeller Institute, New York). J. Biol. Chem., 239: 1177-?(1964). (ACRH-21(p.49-71))

In preliminary experiments it was observed that extracts from the pyrimidine requiring protozoan, Tetrahymena pyriformis, catalyzed the conversion of uracil and 5-phosphoribosylpyrophosphate to both uridine monophosphate and 5-ribosyluracil-5'-monophosphate. The separation and partial purification of the enzymes responsible for UMP and Ψ-UMP biosynthesis in this organism are described. It was shown that whereas UMP synthesis proceeds via the conventional pyrophosphorylase pathway, Ψ-UMP is formed directly from uracil and ribose-5-phosphate by way of an entirely distinct mechanism involving a new enzyme which has been tentatively called Ψ-UMP-synthetase. This latter finding constitutes the first clearly defined description of the enzymatic formation of the carbon-carbon ribosyl linkage of Ψ-uridine and its derivatives. (C.H.)

33247 STUDIES ON THE INTERACTION BETWEEN BOVINE SERUM ALBUMIN AND NATURAL AND SYNTHETIC POLYRIBONUCLEOTIDES. III. IMMUNOLOGIC STUDIES ON HEATED MIXTURES OF POLYRIBONUCLEOTIDES AND BOVINE SERUM ALBUMIN. S. Yachnin. J. Immunol., 91: 528-?(1963). (ACRH-21(p.132-43))

Studies on the interaction between bovine serum albumin (BSA) and natural and synthetic polyribonucleotides indicate that antibodies formed to heated mixtures show no specificity for polynucleotide moiety. However, antigenic differences were detected between simple heat denatured BSA and BSA denatured in the presence of polynucleotide. (C.H.)

33248 THE ACCUMULATION OF RADIONUCLIDES BY THE THORNBACK RAY, RAIA CLAVATA L., IN THE IRISH SEA. John Mauchline and Angela M. Taylor (United Kingdom Atomic Energy Authority, Windscale, Cumb., Eng.). Limnol. Oceanog., 9: 303-9(July 1964).

A study of the levels of radionuclides accumulated by the thornback ray, Raia clavata, a nonmigratory species, was made in the Irish Sea, where these fish have lived most of their lives in an environment contaminated with the fission products ^{106}Ru, ^{144}Ce, ^{137}Cs, and ^{90}Sr. The relative importance of the different radionuclides as contaminants of fish tissues and the importance of determining whether a steady-state system exists in a marine area receiving radioactive wastes are discussed. (auth)

33249 FURTHER STUDIES ON THE EFFECT OF EDTA GIVEN ORALLY ON THE ABSORPTION AND EXCRETION OF LEAD. Dariusz Brykalski and Wanda Bolanowska. Med. Pracy, 15: 133-8(1964). (In Polish)

The effect of EDTA given orally upon the absorption and excretion of lead administered in the same way was studied in rats after administration of 300 μg of Pb^{2+} labeled with ^{210}Pb. To the animals of the experimental group (8 rats) the water versenate solution was given as drink in five portions of 5 mg each during 2 days. No versenate was administered to animals of the control group. The rats were kept in specially built cages, where excreta and urine could be collected separately. Forty-eight hr after the lead was administered the animals were killed and the ^{210}Pb content was determined in the alimentary tract, in the body, and in urine. The total body retention was generally similar in both groups. EDTA increased the absorption of lead from the alimentary tract, but this increased absorption was compensated with a relatively high excretion, and the total-body retention was not raised. (C.H.)

33250 EFFECT OF DEUTERIUM OXIDE ON WOUND HEALING, COLLAGEN, AND METABOLISM OF RATS. Hyman Rosen (Georgetown Univ., Washington, D. C.), Erving F. Geever, Costan W. Berard, and Stanley M. Levenson. New Engl. J. Med., 270: 1142-8(May 28, 1964).

A Walter Reed strain of male weanling rats was given 16 g of a semi-solid diet mixture daily during the control period then 12 g of food and 4 g of distilled water (for controls) or 25% D_2O. After these rats had been on the diet and water or D_2O for 20 days, paravertebral skin incisions were made, and four polyvinyl sponges were implanted in the abdominal wall. Then they were killed on the 27th or 47th postoperative days. The rats allowed to drink 25% D_2O achieved an eventual equilibrium body concentration of about 15%. The skin wounds healed abnormally as compared to rats given water. Wounds excised both at 27 and 47 days after infliction showed that breaking strengths in the deuterated rats were about 40% less than those in controls. Formalin fixation of the tissues corrected this deficiency. Histologic examination of the wounds revealed focal porosity due to decreased number, caliber, and density of collagen fibers in deuterated rats as compared with controls. There were no apparent abnormalities in ground substance or cellular population of deuterated wounds. The implanted sponges of the deuterated rats were normal histologically and in their amounts of bound hydroxyproline, estimated chemically to assess collaged content. Tail-tendon collagen of the deuterated rats dissolved in acetic acid was normal in fractionation, melting temperature, and optical rotation, indicating that the abnormalities induced by D_2O depend on the entire fibrous structure and not on the collagen macromolecule alone. Although the deuterated rats showed no gross pathologic abnormalities at autopsy, they weighed on the average 15% less than controls at the end of the experiment (67 days) although their food intake was identical. They had drunk 20% more D_2O and water than the controls had drunk water. Their response to operation was more marked than that of the controls in terms of urinary excretion of N, Na, and K. Spermatogenesis was depressed in the deuterated rats. It is concluded that the deleterious effects of D_2O on wound healing are due mainly or entirely to the solvation effects of the D_2O on developing collagen, that direct incorporation of D into the collagen macromolecule plays little part, and that nutritional and endocrinologic factors are also of minor importance. (BBB)

33251 CAPACITY OF I^{131} TO CONCENTRATE IN THE SKIN OF ANIMALS OF DIFFERENT SPECIES. Gyorgy Pethes. Orszagos Atomenergia Bizottsag Izotop Alkalm. Szakbizottsaganak Kladv, 3: No. 3, 71-6(1962).

Experiments were carried out on 14 frogs, 9 one-day-old chicks, 7 mice, 43 albino rats, 6 guinea pigs, 7 cats, 12 newly-born puppies, 1 colt, and 17 hybrid gray and white rats. The animals were administered ^{131}I intramuscularly and intraperitoneally. The experiments continued for periods of four to six hours. The animals were then bled and the content of ^{131}I in the skin, renal organs, liver, muscles, and plasma was determined. The capacity of ^{131}I to concentrate in the skin of the gray and white rats as well as in the hybrids of the gray and white rats was established in contradistinction to the other animals (the concentration was somewhat lower in the hybrids). (Referativnyy Zhurnal, Biologicheskaya Khimiya, No. 5, 1964)

33252 METABOLISM OF RADIOACTIVE CERIUM ADMINISTERED BY THE INTRATRACHEAL ROUTE IN WHITE RATS. Tomas Trnovec, Milan Beno, Anna Pleskova, Eugen Hantabal, and Vlastimil Rusek (Inst. of Hygiene of Work and Occupational Diseases, Bratislava). Pracovni Lekar., 16: 197-202(1964).

The organ activity and excretion of ^{144}Ce was studied in young rats after intratracheal injection of carrier free $^{144}CeCl_3$. The activity of the radioactive substance declined in the course of the 1st month with an approximate half life of two weeks; later excretion via the lungs was slower. The highest activity was found in the liver and the bones; the bones are more important for long term retention. The ^{144}Ce was excreted mainly in feces. (OTS)

33253 TRITIATED PRECURSORS FOR THE LABELLING OF CHROMOSOMES OF HUMAN LEUKEMIA CELLS. F. Gavosto, L. Pegoraro, and A. Pileri (Università, Turin). Rev. Franc. Etudes Clin. Biol., 8: 920-2(1963).

A new technique has been developed in order to investigate in vivo the DNA metabolism at chromosomal level in human leukemia cells. Tritiated thymidine is injected both intravenously and directly within the bone marrow. The rate of incorporation at the chromosome level of the precursor is evaluated by means of autoradiography, associated to the conventional method for the morphological analysis and classification of chromosomes. (Excerpta Med., Sect. XXIII, 1: No. 6 (June 1964))

33254 THYROID UPTAKE AND WHOLE-BODY RETENTION OF ^{131}I IN BOX TURTLES. Everett D. Wilson, William D. Gibbs, and C. C. Lushbaugh (Oak Ridge Inst. of Nuclear Studies, Tenn.). Texas Rept. Biol. Med., 22: No. 1, 211-12(Spring 1964).

A single dose of 5 μC ^{131}I was administered intraperitoneally to both adult and immature male and female turtles (Terrapene carolina carolina). Whole-body retention of ^{131}I was measured at intervals up to and including 35 days.

After 35 days the animals were killed and selected tissues were removed, weighted, and assayed for ^{131}I content. The whole-body retention in adult turtles ranged between 10 and 86% of the administered dose after 35 days; 57% of the animals retained more than 50% of the dose. The thyroid gland contained an average of 76% of the amount retained. The immature animals retained 18 to 49% of the dose after 35 days. Of the amount retained, an average of 82.5% was in the thyroid. (BBB)

33255 EXPERIMENTAL STUDY OF THE RADIATION CONTAMINATION OF ANIMAL FOODS WITH EXTERNAL RADIATION CONTAMINATION OF EGGS. B. Petrovic, J. Gligorijevic, V. Jovancevic, and A. Zagorcic-Jankovic (Inst. for the Application of Nuclear Energy in Agricultural Veterinarian Medicine and Forestry, Zenun, Yugoslavia). Vet. Glasnik, 18: 331-6(1964).

When radioiodine was administered to laying hens, 5.6% was incorporated into the eggs, mostly in the yolk. Uptake by eggs dipped for 10 min to 48 hours into solution of radioiodine was studied. The shell was found to be uniformly radioactive regardless of prior washing; if exposure was over 1 hour, eggwhite and yolk were slightly contaminated also. (OTS)

33256 CONCERNING THE EFFECT OF THE ADRENOCORTICOTROPIC HORMONE (ACTH) AND CORTISONE ON THE PHOSPHATIDE CONTENT AND RAPIDITY OF PHOSPHATIDE METABOLISM IN THE TESTES OF ALBINO RATS UNDER NORMAL CONDITIONS AND AFTER LOCAL X-RAY IRRADIATION. E. A. Pokrovskii and M. I. Petukhov. p.78-83 of "Novye Dannye po Biokhimii Polovykh Zhelez v Norme i pri Nekotorykh Patologicheskikh Sostoyaniyakh (Luchevye Povrezhdeniya i Gipoksiya)." Kalinin, USSR, Knigoizdat, 1963.

Semi-mature male rats were daily administered three units of ACTH intramuscularly for a period of eight days or cortisone in doses of 12 milligrams (I) for a period of four days; one of the testes of the animals was then irradiated with doses of 600 R. Forty-eight hours after the irradiation ^{32}P was subcutaneously administered to the animals. Two days after the irradiation the weight of the testes, their content of water, total phosphorus, and phospholipids (II), and the specific activity of the total phosphorus and (II) remained within the normal limits. The administration of (I) decreased the specific activity of the phosphorus, while the administration of ACTH increased the activity of (II) in the irradiated as well as the nonirradiated rats. (Referativnyy Zhurnal, Biologicheskaya Khimiya, No. 5, 1964)

33257 APPLICATIONS OF O^{18} TO BIOCHEMICAL STUDIES. Mildred Cohn (Univ. of Pennsylvania, Philadelphia). p.45-59 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The unique properties of ^{18}O which make it suitable as a tool for investigating biochemical reactions in vitro on the level of mechanism of enzyme action, and the special properties which limit the use of this isotope as a tracer in intact organisms, are discussed. The participation of the primary oxygen-containing compounds involved in the energy metabolism of most living organisms, namely molecular oxygen, water, and phosphate compounds has been investigated with ^{18}O in purified systems isolated from living cells. These studies have revealed reactions such as the direct participation of molecular oxygen in hydroxylation and other oxidation reactions, the phosphate-water exchange reactions in oxidative phosphorylation and the hydrolysis of adenosine triphosphate, the energy-yielding reaction associated with muscle contraction. The establishment of the site of cleavage of chemical bonds of oxygen with ^{18}O, e.g., in enzyme-catalyzed reactions of phosphate esters, has reinforced the concept of group transfer reactions catalyzed by enzymes and aided in specifying the functional role of various classes of enzymes. (auth)

33258 THE INFLUENCE OF NUCLEAR MASS ON BIOLOGICAL SYSTEMS. D. Rittenberg (Columbia Univ., New York). p.60-70 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The discovery of deuterium and the subsequent concentration of the less abundant stable isotopes of hydrogen, oxygen, and nitrogen have had a profound influence on the development of biochemistry. These isotopes have provided investigators with a procedure for labeling the naturally occurring organic constituents of the living cell and studying their transport and metabolism in the intact cell. Replacement of H_2O by D_2O or H_2O^{18} leads to interference in the delicately synchronized net of chemical reactions in the cell. This leads to inhibition of growth and division. It is likely that these phenomena are connected with changes in the tertiary structure of the proteins and the nucleic acids. (auth)

33259 Sr/Ca RATIO OF SKELETAL ARAGONITES FROM THE RECENT MARINE BIOTA AT PALAU AND FROM FOSSIL GASTROPODS. Heinz A. Lowenstam (California Inst. of Tech., Pasadena). p.114-32 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The Sr/Ca ratios were determined from skeletal aragonites of the marine biota and sea water from Palau, South Pacific, where the temperature and Sr/Ca ratio of the waters are constant throughout the year. The Sr/Ca ratios of the aragonites from all groups of organisms except those of the higher Mollusca are similar or slightly higher than those in sea water. In samples from all phyla with high Sr/Ca ratios, the crystal chemistry is considered the primary control of the Sr/Ca ratios from their skeletal aragonites, whereas physiologic control by the organisms is considered as a second order effect. In agreement with data in the literature, the Sr/Ca ratios from the skeletal aragonites of the more advanced Mollusca were found to be low and indicate strong discrimination against Sr relative to Ca in the carbonate as compared to sea water, and this is related to physiologic control by the organisms. The measured Sr/Ca ratios from aragonitic shells of fossil gastropods from Cretaceous and Pennsylvanian deposits are shown to be higher the older the fossils. The increase in Sr/Ca ratios in the gastropod shells with increase in geologic age is toward the Sr/Ca ratio in present day sea water. It is suggested that this reflects biochemical evolutionary changes of increased discrimination by the gastropod against Sr relative to Ca from the late Paleozoic to the present. (auth)

33260 ESTIMATION OF THE BODY CONTENT FOLLOWING INHALATION OF INSOLUBLE PLUTONIUM. G. W. Dolphin (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/11, 19p. (CONF-448-10)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

The problem of estimating the body content of plutonium following the inhalation of plutonium oxide is discussed. Biological data on ^{239}Pu deposition and excretion are reviewed from beagle dog experiments and from two human

cases. It is concluded that there is evidence for believing that the body content, following an accidental inhalation, can be estimated from the measurements of plutonium excreted in urine at times greater than about 300 days after the intake. Some possible excretion methods are discussed. The radiological protection aspects of insoluble plutonium in the lungs and bronchial lymph nodes are summarized. (C.H.)

33261 THE ASSESSMENT OF RADIOACTIVE BODY BURDENS OF THE ALKALINE EARTHS. E. Lloyd (Churchill Hospital, Oxford). Vienna, International Atomic Energy Agency, 1964. Preprint SM-52/19, 19p. (CONF-448-14)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

The difficulties in obtaining data on the metabolism of bone-seeking radioactive isotopes in man are reviewed with emphasis on problems involving the distribution of the isotope between different bones and the microscopic distribution within the same bone. It is pointed out that, if a full understanding of the metabolism in man is to be obtained, there is at present no alternative but to resort to the use of experimental animals. Results are reported from studies calcium and strontium metabolism of the rabbit, which is the smallest animal to have similar skeletal structure to that of human bone. Strontium-90 and ^{45}Ca were used as tracer in research planned to include as many parameters as possible. These included specific activity measurements of plasma, urine, and faeces, total retention in the skeleton as well as individual bones and in some cases soft tissues. In addition the microscopic distribution of the isotope was studied by quantitative autoradiographic techniques at different time intervals. The results are discussed in the light of various models proposed for the retention of bone-seeking isotopes in mammals and the limitations of each of these models have been assessed. Measurements were made over sufficiently long time intervals compared with the life-span of the rabbit to enable predictions to be made about the long-term behaviour in man. The results indicate that none of the existing models is completely satisfactory but that a modification of the power function is the most useful. The importance of exchange, as well as resorption, for the removal of radioactive isotopes from the skeleton is well illustrated by the quantitative autoradiographic measurements. (C.H.)

33262 MEASUREMENTS OF RADIUM IN RADIUM LUMINIZERS. J. Vennart, G. Maycock, B. Godfrey, and B. Davies (Radiological Protection Service, Belmont, Surrey, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/20, 14p. (CONF-448-15)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

A group of about 500 people, mostly women, who had worked in the radium luminizing industry over a period of about 50 years was measured to assess radium in the body. Measurements were made of both the exhaled radon and that which was retained in the body. The exhaled radon was determined on breath samples taken using specially designed breathing apparatus by means of which radon-free air can be inhaled from a cylinder and subsequently exhaled into a collecting bag. The amount of gamma-emitting radon decay products in the body was measured in a low background laboratory using a sodium iodide crystal scintillation counter. This equipment was calibrated by means of a standard radium source placed at several points in a water-filled plastic model of the human body on the assumption that any radium in the body is distributed uniformly throughout the skeleton. The error of measurement of the total radium content of the body was estimated to be about 0.005 μgm Ra. Twenty people were found to have more than 0.1 μgm Ra in their bodies, the largest measured amount being 0.6 μgm. A further sixty people had amounts in excess of 0.05 μgm but less than 0.1 μgm. These results are correlated with the length of employment and show that no person who commenced working after 1942 has an amount in excess of 0.05 μgm in his body. This date can be related to the introduction of government control over the use of radium in the luminizing industry. (auth)

33263 ASSESSMENT OF THE TOTAL BODY BURDEN OF CAESIUM-137 IN PEOPLE BY THE ANALYSIS OF BLOOD. N. Yamagata (Inst. of Public Health, Tokyo). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/3, 9p. (CONF-448-5)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

Analysis of post-mortem samples for cesium-137 was carried on in Japan because whole-body counters are limited in number and not mobile, making the assessment of the population mean levels inconvenient. However, the collection of muscles from autopsies throughout the country is complicated and inconvenient in that a sample of instantaneous death should be chosen. Considering that only such data as are useful for the assessment of the mean levels of cesium-137 in people are required and it is unnecessary to know individual values, the composite samples of as many individuals as possible would be enough for the analysis. For this purpose, the whole-blood samples were considered as a best substitution for muscles, because the blood collection system covers the whole country, including 47 licensed blood banks and about 100 hospitals. Sampling inspection was made continuously of the citrated whole blood at the National Institute of Health, Tokyo, where about 500 ampoules were checked which represent more than three million donors throughout this country yearly. Less than half the blood in an ampoule was consumed for the inspection and the remaining half was stocked to make a composite for the determination of cesium-137 level. Blood ashes were analysed for the stable cesium content by a neutron activation method. The results afforded the relation between the concentration in the whole blood and the total body amount (1.4 mg for 70 kg man) and this relation would be identical to that for cesium-137 in an equilibrium condition. The results of blood analysis for cesium-137 obtained since June 1963 were compared with those of muscle analysis made during the same period. A good agreement was observed and the blood analysis was found the best means for assessing the total-body burden of cesium-137 in a population. (auth)

33264 THE USE OF GAMMA-RAY SPECTROMETRY IN BIO-ASSAY. A. Holmes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/8, 19p. (CONF-448-7). (AERE-R-3834)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

The use of gamma-ray spectrometry for the determination of radionuclides in bio-assay samples is discussed. This technique has the advantage that direct measurements can be made on untreated samples, thus avoiding tedious and time-consuming radiochemical separations. A second advantage is that a number of radionuclides may be deter-

mined simultaneously in the same sample. The sensitivity of this method for a number of radionuclides commonly encountered in the atomic energy industry is defined in terms of action levels in excreta. These action levels are derived from maximum permissible body burdens, recommended by the ICRP, and a constant excretion rate of 0.1% per day of the MPBB. They are expressed in picocuries of gamma activity, to take the branching ratio into account. Almost all the radionuclides considered can be detected at one tenth or less of the action level, with a ten-minute counting period. The equipment used for gamma-ray spectrometry is described. Data are recorded automatically on punched cards and a computer program is used to deduct the background and to plot the corrected spectrum, which is suitable both for measurement and record purposes. The same program can be used to deduce the relative amounts of a number of known radionuclides in a sample, by a least squares fitting method. The limits of detection for this equipment are calculated for gamma emitters with energies in the range 0.134 to 1.33 Mev and for counting periods of 1, 10, 100, and 1000 minutes. Limits of detection are also calculated for variations in counting geometry, as sample volumes are increased from 400 to 2000 ml. A number of spectra of contaminated urine and fecal samples from occupationally exposed personnel are also included. (auth)

33265 THE ASSESSMENT OF RADIOACTIVE CAESIUM IN MAN. J. Rundo (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/6, 22p. (CONF-448-6)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

The content of ^{134}Cs and ^{137}Cs in the human body may be estimated either by whole body radioactivity measurement or by excretion analysis. Some of the difficulties of these two methods are discussed. (C.H.)

33266 THE ROLE OF FAECAL ANALYSIS IN A BIO-ASSAY PROGRAMME. J. D. Eakins and A. Morgan (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/10, 15p. (CONF-448-9)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964. (AERE-R-4589)

The role of fecal sampling and analysis in a bio-assay program is discussed, with particular reference to the estimation of retained lung burdens of insoluble radioactive materials. Sampling and analysis of feces is often used as a complement to urine analysis, following cases of known or suspected exposure by inhalation of insoluble radioactive materials. Experience has shown that urine analysis alone cannot always be relied upon to give an indication of exposure by inhalation and in any case the results obtained are affected by so many variables that they defy interpretation. The analysis of fecal samples collected after an incident, however, can confirm whether or not a significant intake has occurred and enable an initial estimate of the retained lung burden to be made, by reference to one of the models describing the behaviour of inhaled particles in the lung. The subsequent fecal excretion pattern and particle size measurements on air filter samples representing the inhaled aerosol, if available, can be used to modify the initial estimate. Some examples of excretion patterns obtained from cases of accidental inhalation of insoluble compounds of ^{170}Tm and ^{239}Pu are described. It is pointed out that radionuclides of certain elements are preferentially eliminated in feces, whatever the route of intake. These include ^{65}Zn, ^{144}Ce, ^{210}Po, ^{226}Ra, ^{227}Ac, and inhaled ^{239}Pu. In cases of accidental exposure to such radionuclides, the results of urine analysis alone cannot be used as an index of exposure and in the absence of other methods of detection fecal sampling and analysis may provide valuable data. (C.H.)

33267 DETERMINATION OF PLUTONIUM BODY BURDENS FROM MEASUREMENTS OF DAILY URINE EXCRETION. S. A. Beach and G. W. Dolphin (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/12, 16p. (CONF-448-11)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

Mathematical models are presented that represent the metabolism of Pu in man. The models use the original data from 16 human experiments, as reported by Wright Langham and others, and a simple compartment model. The functions obtained from this analysis, relating the body burden to the daily excretion in urine following an injection, are used in proposed mathematical models for the slow release of soluble plutonium into the blood stream from a wound site or the lungs. The results of calculations on the model for various hold-up times at the wound site or lungs are presented graphically. The presently available data on the biological variation between men and in the day-to-day plutonium in urine excretion in an individual are analysed and discussed with special reference to the best design of a routine urine sampling program. (C.H.)

33268 THE ESTIMATION OF INTERNAL CONTAMINATION WITH URANIUM FROM URINE ANALYSIS RESULTS. S. Jackson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/15, 14p. (CONF-448-12)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

The most common cause of internal contamination with uranium is inhalation of uranium dust. Soluble uranium compounds are rapidly absorbed from the lungs, and most of the uranium entering the circulation is rapidly excreted in the urine. The intake of soluble uranium can be estimated from the uranium content of samples taken immediately afterwards. It is a special feature of soluble compounds of natural uranium that the primary hazard is not radiological but toxicological due to chemical effects of uranium deposited in the kidneys. Some uranium is also deposited in the skeleton, but the radiological hazard to bone is less serious, in the case of natural uranium, than the toxicological hazard to kidney. In the case of insoluble compounds, the critical hazard is radiological exposure of the lungs, due to the persistence there of some of the inhaled uranium. With soluble compounds of highly-enriched uranium, the primary hazard is also radiological; due to the high specific activity, the chemical effects on the kidneys are less serious than the irradiation of bone, which thus becomes the critical organ. For these cases of radiological hazard, it is better to attempt to assess the retained body burden rather than the intake of uranium. This may be done by analysing samples taken not immediately after exposure, but after some time has elapsed. Samples taken after a holiday are probably the best material available in industrial practice, but it may be necessary to accept samples after only a weekend of removal from exposure. (auth)

33269 GAMMA-SPECTROMETRIC AND HISTO-AUTORADIOGRAPHIC INVESTIGATIONS ON THE DISTRIBUTION AND EXCRETION OF THORIUM AND ITS DAUGHTERS IN THOROTRAST PATIENTS. A. Kaul (Max-Planck-Institut für Biophysik, Frankfurt am Main). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/54, 32p. (CONF-448-21)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

The estimation of the internal radiation dosage from thorium and its daughters in thorotrast patients presupposes the knowledge of the distribution of the nuclides of the thorium series within the organism. Moreover, the knowledge of the excretion of the thorium daughters with feces, urine, and exhalation is of importance. In a series of cases of ThO_2 incorporation 10 to 20 years ago mainly two kinds of distribution patterns were observed. These included the deposition of ^{232}Th and its daughters mainly within the liver, and spleen and bone marrow, and the simultaneous deposition of the x-ray contrast medium at the spot of the former injection. The thorotrast depots were analysed quantitatively in vivo and localized with a NaI (Tl)-total body γ-ray spectrometer (HUCO). It was also possible from excretion measurements to estimate the radioactive equilibrium state between ^{232}Th and its daughters in the physiological steady state. Parallel analyses of section materials of former thorotrast patients showed similar results. The question of the radioactive equilibrium state between ^{232}Th and its daughters ^{228}Ra and ^{228}Th was investigated. The ^{232}Th and ^{228}Th content of different samples of liver, spleen, bone marrow, and marrow-free bone were determined and the ^{228}Th activities compared with results of γ-spectrometric analyses. The observed activity ratios $^{232}Th/^{228}Th$ served as a base for calculations of both the ^{232}Th and ^{228}Th content of samples from histoautoradiographic investigations. Both methods and the results of the γ-spectrometric and histo-autoradiographic investigations are discussed in detail. (C.H.)

Radiation Effects

Refer also to abstract 33997.

33270 (NIRS-2(p.23-6)) BIOCHEMISTRY AND BIOPHYSICS. (Japan. National Inst. of Radiological Sciences, Tokyo).

Experiments on contraction of glycerinated mitochondria, effects of γ-irradiation on the contraction system in glycerinated mitochondria, changes in the content of adenosine nucleotides during early development of the sea urchin (Pseudocentrotus depressus), the influence of x-irradiation on ^{65}Zn uptake by mice testes, and the biosynthesis of sinigrin are reported. (H.M.G.)

33271 (NIRS-2(p.26-31)) CYTOLOGY AND MORPHOLOGY. (Japan. National Inst. of Radiological Sciences, Tokyo).

Experiments are reported on: behavior of the telophase chromosome-group following microbeam irradiation; mode of chromosome aberrations by ethyleneimine and triethylene melamine; effects of gamma-irradiation on the histogenic aggregation of dissociated cells from chick embryos; embryonic development in encysted dry eggs of Artemia salina, with special reference to the cell numbers, DNA-content and chromosomes; and comparative studies on the effects of gamma rays, high temperature, and carzinophilin upon encysted dry eggs of Artemia salina. (H.M.G.)

33272 (NIRS-2(p.31-42)) PHYSIOLOGY. (Japan. National Inst. of Radiological Sciences, Tokyo).

Experiments are reported on the protective action of dinitrophenol against the lethal effects of x-irradiation in toad embryos, the effect of total body γ-irradiation on electrolyte distribution in rat blood, the effects of fractionated irradiation on encysted dry eggs of Artemia salina, the relation between survival time after exposure to x rays and dose of radiation in fish (Carassius auratus and Oryzias latipes), the effects of ionizing radiations on sodium metabolism in goldfish (Carassius auratus), the histopathology of the intestinal epithelium of goldfish after whole-body x-irradiation, histological responses of the adrenal cortex of the goldfish (Carassius auratus) to x-irradiation, radiation effects on the regulating mechanism of fish melanophore, the role of the pituitary gland in melanization in the skin of the goldfish (Carassius auratus) following x-irradiation, the protective action of reserpine against x-irradiation in fish (Oryzias latipes), x-ray effect on the adrenal cortex function of rats, the effect of x-irradiation on the embryonic development of the mouse, and specificity of lymphatic organs to radiation damage. (H.M.G.)

33273 (NIRS-2(p.42-8)) GENETICS. (Japan. National Inst. of Radiological Sciences, Tokyo).

Experiments on the early phenotypic expression in the transformation of Diplococcus pneumoniae, radiosensitivity of Paramecium in different stages of conjugation, mutagenic effects of 4-nitroquinoline-N-oxide in Drosophila melanogaster, mutagenic effects and chromosome breaking ability of 4-nitroquinoline-N-oxide in Drosophila melanogaster (injection experiment), modification of mutation rates by storage of irradiated spermatozoa in the female Drosophila melanogaster, estimation of mutation rate in rare recessive traits, estimation of recessive gene frequencies from data on consanguineous marriages, and random mating and frequency of consanguineous marriages in human populations are reported. (H.M.G.)

33274 (NYO-910-1) RADIATION STUDIES: FREE RADICAL PRODUCTION AND SECONDARY ELECTRON SPECTRA. Progress Report, May 1, 1963–May 1, 1964. John S. Laughlin (Sloan-Kettering Inst. for Cancer Research, New York). July 1, 1964. Contract AT(30-1)-910. 9p.

The progress reported includes improvement of the sensitivity of the electron spin resonance spectrometer with automatic frequency control, measurement of secondary electron spectra in tissue-equivalent media, LET vs dose and LET distribution graphs, and a proposed meson beam project. (D.L.C.)

33275 (NYO-910-2) RADIATION STUDIES: RADIATION-CHEMICAL MECHANISMS IN SIGNIFICANT BIOLOGICAL SYSTEMS. Progress Report, May 1, 1963–May 1, 1964. John S. Laughlin (Sloan-Kettering Inst. for Cancer Research, New York). July 1, 1964. Contract AT(30-1)-910. 19p.

Progress is reported in studies on the influence of oxygen on changes in viscosity and hyperchromicity of γ-irradiated DNA from salmon sperm and calf thymus, the isolation of DNA from Escherichia coli, and the effects of sulfhydryl compounds and other dose-modifying chemicals on the radiosensitivity of E. coli. Cysteamine and 3-chloropropyl mercaptan protected E. coli against the effects of radiation while thioglycolic acid, which also contains an active sulfhydryl group, was a radiation sensitizer. Data are included on the effects of 5-bromodeoxy-

uridine and 5-fluorodeoxyuridine on recovery of sublethally irradiated mammalian cells in cultures. (C.H.)

33276 (NYO-910-7) RADIATION STUDIES: A STUDY OF THE EFFECTS OF X-RAYS ON THE BONES OF LIVING MICE. Progress Report, May 1, 1963–May 1, 1964. Helen Q. Woodard (Sloan-Kettering Inst. for Cancer Research, New York). July 1, 1964. Contract AT(30-1)-910. 6p.

Progress is reported in a study on the effects of x radiation on the composition of the tibias of mice. One tibia of each mouse was exposed to 1200, 1600, or 2000 r of x radiation while the other hind leg and the remainder of the animal was shielded. At various times up to 4 mo. after irradiation the mice were killed and both tibias were analyzed for wet weight and water weight and for N content. The specimens were then ashed, and the weight of the ash and Ca and P contents were determined. Tracer doses of ^{89}Sr were administered to some mice before the mineral content was determined. Preliminary results are reported. A study of the variation with age in the composition of human cortical bone was completed. (C.H.)

33277 (STI/DOC/10/28(p.21-38)) HEALTH PHYSICS AND RADIATION PROTECTION. (International Atomic Energy Agency, Vienna).

Experimental methods and results are described for several studies on radiation protection. (1). It was demonstrated that low doses of x rays cause an immediate drop in injection pressure of the mucopolysaccharide connective tissue matrix in abdominal muscle fascia of rats. X radiation caused the immediate depolymerization of mucopolysaccharide macromolecules of fresh synovia, studied by measurement of relative viscosity. Cystamine, thiosulfate, AET, and serotonin afforded protection against radiation effects on mucopolysaccharides, but molecular oxygen had the same protective power. The water-permeability of isolated connective tissue membranes was found to be very sensitive to the combination of weak mechanical tension and x radiation. The phenomenon of gastric retention after doses of 100 to 300 r x radiation was confirmed in rats. It was concluded that liberation of adrenaline and serotonin together was the cause of retention. It was found that in hypophysectomized frogs the aggregated melanophore pigment expanded in response to 400 r whole-body x radiation. The effect was shown to be mediated by the liberation of neurohormones, especially serotonin. Liberation of serotonin and of adrenaline from superior uterine horns of rats was shown to increase after exposure to 1000 r x radiation. The effects of free amines in circulating blood on the morphology of erythrocytes was investigated as a possible index of x ray sensitivity of normal individuals and patients. Various combinations of bioamines were tested for their radioprotective effect in mice. Local x radiation doses of less than 200 r were found to induce atheromatosis in hyperlipemic rabbits. Histologic examination of human tissue, obtained from necropsy or biopsy of patients after radiotherapy, invariably showed identical arterial damage in the irradiated area. (2). A method of two-step grafting of hematopoietic and germinal tissues was investigated in mice as a means of counteracting incipient radioinduced sterility. The use of pooled hematopoietic cells from 50 antigenically heterogeneous donors resulted in successful transplantation of ovaries or their tissues in mouse radiation chimeras. Male radiation sterility was found to be an unsatisfactory experimental model for transplantation therapy. (3). The effects of x radiation, γ radiation, and ultraviolet radiation on the structure and metabolism of nucleic acids and the effects of treatment of irradiated organisms by native nucleic acids extracted from intact organisms were studied in Salmonella typhimurium, rat liver cells, and L-strain cells in tissue cultures. The structures of newly synthesized DNA and RNA in x and uv irradiated bacteria were significantly damaged as judged by changes of the physicochemical characteristics and the base composition of these constituents; the structures of resting rat liver nuclear RNA fraction and the post-microsomal RNA fraction were damaged very early after $LD_{100/30}$ of x radiation, as judged by the base composition and ratio of the specific activities of RNA pyrimidines, whereas the structure of the microsomal fraction was almost normal. Recovery from radiation injury of irradiated rats ($LD_{100/30}$), cells cultivated in vitro, and bacteria (LD_{50}) was achieved with native isologous and homologous DNA. Heterologous DNA, nuclease digest products, and nucleic acid precursors were inactive. A significant restoration of the synthesis of antibodies was also achieved by treatment with native isologous organ-specific nucleic acid. (4). Iron-59 was used as a tracer in studies of the physiological properties of hematopoietin and its role in hematopoietic regeneration in irradiated mice, guinea pigs, rabbits, and dogs. It was concluded that post-irradiation bleeding stimulates hematological regeneration and increases the percentage of surviving lethally-irradiated experimental animals. Erythropoietin appeared to be an important factor of hematological recovery in the irradiated animals, but it has no protective effect against radiation injury. (5). Calcium-47 was shown to be a useful tool in the investigation of numerous problems of Ca metabolism, including detection and differential diagnosis of several types of malignant and non-malignant skeletal lesions. Results are compared with results using ^{45}Ca, ^{46}Ca, ^{48}Ca, and ^{85}Sr as tracers in studies of Ca metabolism in man. (6). The incorporation of ^{32}P into synthetic bone-like material, into bone and tooth powder in vitro, and into bones and teeth of normal and rachitic rats under manipulation of vitamin D intake was studied. It was concluded that bone mineral consists of several mineral phases, and that proportions and transformations in rats depend on age and metabolic state. Vitamin D apparently increased the rate of bone dissolution. (7). The effects of doses of 25 to 125 r x radiation on the phagocytic activity of neutrophiles were studied in rabbits using the ^{32}P-carbon black tracer method. It was concluded that changes in phagocytosis precede changes in leucocyte count and may be used as an early biological index of radiation injury. (C.H.)

33278 (STI/DOC-10/28(p.39-66)) RADIOBIOLOGY. (International Atomic Energy Agency, Vienna).

Results are summarized from diverse radiobiological studies. (1). Reaction mechanisms involved in primary radiation lesions and the possibility of sensitizing microörganisms to ionizing radiations were studied in cultured mouse lymphoma cells and bacteria. An approximate inverse relation was found between the DNA content of cells and their radiosensitivity. Irradiation in the presence of iodoacetamide resulted in a marked decrease in the survival of certain radioresistant bacteria. It was concluded that the radiosensitivity of microörganisms can be changed. (2). Studies on the mechanism of activation and inactivation of bacterial spores with ionizing radiations showed that different types of effects come into play as the radiation dose is increased. Low doses

stimulated germination of Bacillus subtilis spores, whereas higher doses inhibited germination. Radiation effects on the growth of cells from irradiated spores also manifested themselves differently depending on the dose. Lower levels affected primarily the reproductive system and higher doses affected certain intracellular synthetic mechanisms. (3). Quantitative data were obtained on the survival of guinea pig kidney cells cultured in vitro following exposure to doses of x radiation up to 700 r. The causal significance of morphological abnormalities in lethal radiation effects was studied. The reproductive death of cells was closely related to the appearance of giant cells in the irradiated progeny, whereas it displayed no simple correlation to changes in the number of chromosomes. The effects of x radiation were compared to those of nitrogen mustard. The abnormalities induced by the two agents displayed a general resemblance, but some indirect evidence was obtained that the action mechanism was not the same. (4). The effects of various doses of x and γ radiation, administered to the whole-body or head, on the nervous system of cats and rats was studied using a technique by which electrodes were implanted in the encephalon, certain encephalic activities were electrically stimulated, and the electro-physiological responses and spontaneous activities recorded for unanesthetized animals. Data are presented on the effects of γ radiation on response of the visual cortex and on the effects of x radiation up to a total dose of 190,000 rad on the sympathetic transmission of the superior cervical ganglion as measured in studies in which one of the ganglions was exposed to radiation, the body was shielded, and the other ganglion was used as a control. The development of the response of the ganglion after irradiation was also followed in excised preparations. (5). Results are reported from an investigation of the effects of x radiation on the genetic material of bacteriophages with emphasis on the fractionation, purification, and biological activity of irradiated DNA. (6). The lysogenic system of Staphylococcus albus, consisting of lysogenic bacteria P(w), the sensitive bacteria W5, and the phage W, was found to be a suitable biological dosimeter for doses of x radiation of 1 r or less. It is suggested that the system can be used in the investigation of the threshold problem in radiobiology. (7). The peripheral metabolism of thyroid hormones via dehalogenating pathways and mechanisms regulating thyroid-pituitary interactions were studied in rats and pituitary homogenates using ^{131}I and ^{131}I-labeled thyroid hormones. From the results obtained it was concluded that the classical theory of a feed-back mechanism regulating thyroid-pituitary interplay, in which the circulating concentration of thyroid hormone play a primary role, should be modified and more attention should be given to alterations of the intracellular metabolism of the thyroid hormone as a factor involved in the regulation of thyrotropic hormone secretion by the pituitary gland. Applications of the findings in the induction of experimental goiter and in the elucidation of the causes of some types of human goiter are discussed. (8). The effects of various doses of β radiation on metabolism of the central nervous system were studied in rats after the intraperitoneal injection of ^{32}P. Animals were sacrificed at intervals of 2 to 100 days after a single dose of 125 μc ^{32}P/100 g body weight, treatment twice a week to a dose of 320 to 350 μc/100 g per rat, or administration of 4 doses totalling 500 μc/100 g given over a 37-day period. The brain cortex, diencephalon, hypothalamus, cerebellum, rhinencephalon, pons-medulla, and spinal cord were examined by biochemical methods. The different areas of the central nervous system were found to vary in radiosensitivity. (C.H.)

33279 (TID-20823) INVESTIGATIONS ON MUTABILITY OF POLYGENES AND ON UTILIZATION OF INDUCED GENETIC VARIABILITY. Progress Report. R. E. Scossiroli (Pavia, Italy. Università. Istituto di Genetica). Apr. 1, 1964. Contract IAEA 61/US. 17p.

Progress is reported in studies on radioinduced mutations of plant polygenes and the use of induced genetic variability to improve the yields of maize and wheat. Data are presented on the yield of maize from progenies and crosses of progenies obtained after exposure of the tassel to x radiation doses ranging from 500 to 3000 r. The sugar content of the stalk at the time of ear harvest was also determined. Estimates were made of the genetic variability in R_3 and R_4 generations and sublines of T. durum and T. aestivum varieties of wheat from seed exposed to doses of 2000, 4000, or 8000 r x radiation. A study was made of covariation for all the observed traits and preliminary data are included. (C.H.)

33280 (TID-20831) PROBLEMS IN RADIATION EMBRYOLOGY. A. THE EFFECT OF EMBRYONIC IRRADIATION ON ADULT LIFE EXPECTANCY AND ADULT PATHOLOGY. B. THE EFFECT OF EMBRYONIC IRRADIATION ON POSTNATAL BIOCHEMICAL AND PHYSIOLOGICAL PROCESSES. C. THE INDIRECT EFFECT OF IRRADIATION ON MAMMALIAN EMBRYOGENESIS. Seventh Year Progress Report, July 1, 1963–June 31, 1964. (Jefferson Medical Coll., Philadelphia). Contract AT(30-1)-2071. 9p.

Progress is reported in studies on the effect of embryonic exposure to various doses of x radiation on postnatal biochemical and physiological processes, adult pathology, and life expectancy of rats and mice. The effects of irradiation of the ovary, uterus, and embryo on embryonic death were also studied in pregnant rats. A list is included of publications during the period covered by this report. (C.H.)

33281 (TID-20844) QUANTITATIVE POPULATION GENETICS OF MICE UNDER IRRADIATION. Progress Report, July 1, 1963–June 30, 1964. Earl L. Green, Thomas H. Roderick, and Gunther Schlager (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). July 16, 1964. Contract AT(30-1)-1979. 7p.

Progress is reported in the discovery, isolation, and analysis of genetic factors affecting radiation resistance in mouse populations. Preliminary results are reported from an empirical analysis of the effects of high-energy x radiation on genetically determined fitness characteristics of mouse populations. (C.H.)

33282 (TID-20876) TERMINATION REPORT [ON RADIATION EFFECTS ON LIVING TREES]. John R. Hamilton (Georgia. Univ., Athens. School of Forestry). June 1964. Contract AT(40-1)-2905. 51p.

Results are reported from the examination of the secondary xylem tissues of representative angiospermous and gymnospermous tree species for anatomical and mechanical effects of in vivo exposure to ionizing radiation. The effects of irradiation were evaluated in terms of cellular aberration, tissue disorganization, and microtensile strength. Data are presented on Quercus alba and Liquidambar styraciflua exposed as seedlings to acute γ-slow neutron radiation. (C.H.)

33283 (TID-20889) THE ACTION OF RADIATIONS ON SOME BIOLOGICAL MODEL SYSTEMS. Final Report, June 11, 1963–June 10, 1964. Gabriel Stein (Hebrew Univ., Jerusalem). Contract AT(30-1)-3242. 18p.

Progress is reported in studies on the effects of ionizing radiations on several biological model systems. Data are included from studies on the role of oxygen on radiation effects in gelatin systems ranging from dilute solutions to strong gels; the effects of radiation on reactions of trypsin and chrmotrypsin in aqueous solutions at different pH values and concentrations; and radioinduced excited states in biological systems with emphasis on aromatic molecules, oxidation-reduction processes, and the influence of Brownian motion on resonance transfer of electronic excitation energy in solutions. (C.H.)

33284 (AEC-tr-5836) EFFECT OF IONIZING RADIATIONS ON PLANTS. I. M. Vasil'ev. Translated by Lydia Venters (Argonne National Lab., Ill.) from Deistvie Ioniziruyushchikh Izluchenii na Rasteniya. Izdatel'stvo Akademii Nauk SSSR, Moscow, 1962. 1963. 264p.

This book was previously abstracted from the original language and appears in NSA as 17: 5905. (L.T.W.)

33285 (JPRS-25502) DETERMINATION OF CERTAIN TRACE ELEMENTS IN RADIATION DERMATITIS. A. Ya. Prokopchuk, A. T. Sosnovskii, M. Z. Yagovdik, and Z. I. Orlova. Translated from Vestsi Akad. Navuk Belarusk. SSR: Ser. Biyal. Navuk, 92-6(1964). 14p. (TT-64-31774)

The effects of radiodermatitis on the content of Co, Ni, Cu, and Zn in the skin and blood of rabbits was investigated. The quantitative content of the trace elements was determined by colorimetric methods. The amount of Co and Zn in the blood and affected skin of rabbits had a tendency to increase. The amount of Ni in the blood did not appreciably change, but in the affected skin a tendency to increase was noted. At the height of the development of radiation dermatitis there was an increase of the concentration of Cu in the blood and in the affected skin. An increase of the amount of Co, Ni, and Cu was also observed in the blood of patients ill with radiodermatitis; the increase of the amount of zinc was of no essential importance. (C.H.)

33286 (UCRL-Trans-1068) CHARACTERISTICS OF THE BIOLOGICAL EFFECTS AND RBE OF HIGH-ENERGY PROTONS. Yu. G. Grigor'ev, N. G. Darenskaya, M. P. Domshlak, A. V. Lebedinski, Yu. G. Nefedov, and N. I. Ryzhov. Translated by D. A. Nimidoff (Univ. of California, Lawrence Radiation Lab., Berkeley), from IAEA Preprint No. SM-44/62 presented at the Symposium on Biological Effects of Neutron Irradiations, Upton, N. Y., 1963. 10p.

Data are summarized from a number of studies on the biological effects of protons with energies of 126, 240, and 510 Mev in laboratory animals. Data are included on the relative biological effects of single and fractionated doses of protons, x, and γ radiation in mice, rats, and dogs as determined by the life span and biochemical and histological examinations of the exposed animals. (C.H.)

33287 EXCRETION OF ESTROGENS, 17-KETOSTEROIDS AND 17-OH-CORTICOSTEROIDS IN IRRADIATED CERVICAL CARCINOMA. A. Lindell and M. O. Raud (Uppsala Univ.). Acta Obstet. Gynecol. Scand., 42: 311-23(1963).

Fractionated oestrogen determinations according to Brown (estrone, estradiol and estriol) were made in 17 cases of squamous cell carcinoma of the cervix uteri in fertile women. The determinations were carried out before, during, and after radiotherapy. The opinion that estrogen production is exceptionally high in women with cervical cancer could not be confirmed. On the contrary, for all 3 estrogen fractions the values were throughout slightly below normal in this study. After irradiation of the ovaries with a dose of 3000 to 4000 R, the estrogen excretion declined rapidly. The decrease was complete with 6 weeks, reaching postmenopausal values. The decrease occurred at about the same rate as after oophorectomy. The decrease for estriol was permanent. The estrone and especially the estradiol production, however, increased again, according to titrations carried out more than 4 months later. The pretherapy estriol/estrone + estradiol quotient of 1.2 dropped to 0.5. Of the 17 cases investigated, 5 died within 18 months, all of cervical cancer. Two years post irradiation the remaining 12 cases are still asymptomatic. No significant abnormal estrogen excretion could be noted in the cases who died. The excretion of 17-ketosteroids and 17-OH-corticosteroids was within normal limits and remained constant during and after irradiation therapy. (Excerpta Med., Sect. XXIII, 1: No. 6 (June 1964))

33288 RADIATION NEPHRITIS: LIGHT AND ELECTRON MICROSCOPIC OBSERVATIONS. Seymour Rosen, Martin A. Swerdlow, Robert C. Muehrcke, and Conrad L. Pirani (Univ. of Illinois, Chicago). Am. J. Clin. Pathol., 41: 487-502(May 1964).

Two cases of radiation nephritis are described, and findings are compared with those of other reports. The results of all previously reported cases of radiation nephritis are tabulated with regard to age, disease for which radiation was given, dose, latent period, and renal histology. (TCO)

33289 MICROANGIOGRAPHY AS A TECHNIQUE. RADIATION EFFECT VERSUS ARTIFACT. Philip Rubin (Univ. of Rochester, N. Y.), George W. Casarett, Samual S. Kurohara, and Masamichi Fujii. Am. J. Roentgenol., Radium Therapy Nucl. Med., 92: 378-87(Aug. 1964).

Microangiography is discussed as a technique for studying ing the vasculopathophysiologic effects of irradiation. Technique variables discussed are: site of injection, pressure of injection, length of injection, type of opaque medium, heparinization, state of the animal, displacement of blood, fixatives, thickness of the section, photographic emulsion, x-ray source, and tissue Roentgenography. The two major artifacts of microangiography are identified as: poor filling, due to low pressure, leakage of opaque medium, vascular spasm, etc.; and overfilling, due to overinjection secondary to high pressure, fine particulate size, traumatic handling of tissue, etc. To be certain that lesions noted on microangiograms are indeed true vascular lesions, the following aids are suggested: correlative histologic sections are of great value, as in radioautography, for orientation, for evaluation of penetration and distribution of opaque medium and for identification of the histologic lesion; control specimens which include both normal and diseased organs preferably in the same animal are valuable; control histologic sections without injection are important in the recognition of any tissue distortions due to the injection of contrast medium; and associated functional studies help define sensitivity of microangiography in the detection of early changes in the vascular bed. (H.M.G.)

33290 DELAYED POST-THERAPEUTIC RADIONECROSES OF THE CENTRAL NERVOUS SYSTEM. P. F. Girard, M. Tommasi, and M. Rochet. Ann. Anat. Pathol., 9: 165-80(Apr.-June 1964). (In French)

Some observations on the development, nature, and occurrence of delayed necroses are summarized, together

with the different explanations proposed for such necroses. The delayed necroses appear as a necrosis with imbibition of the nervous parenchyma by a substance akin to amyloid, accompanied by intense vascular lesions and demyelinization. 53 references. (D.C.W.)

33291 RADIATION BLEEDING. George Brecher (National Institutes of Health, Bethesda, Md.). Ann. N. Y. Acad. Sci., 115: 387-8(July 9, 1964).

Literature on the hemorrhagic tendency following whole-body irradiation is briefly reviewed. It is concluded that thrombocytopenia, a sequel of the generalized bone marrow aplasia, is the etiologic agent. Treatment with platelet transfusion is discussed clinically and experimentally. Vascular response to radiation is reviewed. (H.M.G.)

33292 EFFECT OF GAMMA IRRADIATION OF BACILLUS SUBTILIS SPORES ON SPORE GERMINATION AND ON VEGETATIVE GROWTH. J. Hermier (INRA, Jouy-en-Josas, France). Ann. Nutr. Aliment., 17: B439-47(1963). (In French)

The normal germination of spores of B. subtilis is described in order to have a basis on which to judge the effects of radiation. The spores, maintained under rigorous conditions, were exposed to ^{60}Co radiation at doses from 0.2 to 3.0 Mrad. The two germination stages were studied separately. The results showed that the effects of irradiation in spores differ on at least two points from the effects of irradiation in non-sporulated microörganisms. In B. subtilis the inhibition of cellular division is a delayed reaction, occurring only after at least four divisions. The number of survivors is independent of the culture medium. (J.S.R.)

33293 INFLUENCE OF CULTURE CONDITIONS ON THE RADIATION RESISTANCE OF SOME LACTOBACILLI. P. Dupuy and O. Tremeau (Institut National de la Recherche Agronomique, Versailles, France). Ann. Nutr. Aliment., 17: No. 6, B427-37(1963). (In French)

The effects of culture conditions on the radiation resistance were studied in the Lactobacilli fermenti NCDO 215, L. brevis NCDO 110, P. cerevisiae ATCC 8081, L. arabinosus (LA_1), and a special selection of this last strain L. arabinosus 30 R No. 2, which has an increased radioresistance. Effects of stage of cellular division, growth phase, pH of the medium, type of medium, and growth rate were determined. The resistance of the Lactobacilli varied within very narrow limits. The highest resistances were those from cells collected when the growth was arrested. Bacteria collected in media conducive to their growth have similar resistances. Cultivation in deficient media increases the sensitivity, but the radioresistance could not be significantly increased by modifying the culture conditions. (J.S.R.)

33294 METABOLIC ALTERATIONS AFTER TOTAL BODY DOSES OF X-RADIATION. EFFECT OF IRRADIATION OF NORMAL LIVER ON DNA SYNTHESIS AFTER PARTIAL HEPATECTOMY. N. Fausto, T. Uchiyama, and J. L. Van Lancker (Univ. of Wisconsin, Madison). Arch. Biochem. Biophys., 106: 447-54(July 20, 1964).

DNA and RNA synthesis in regenerating rat liver were investigated in vivo and in vitro in animals irradiated prior to partial hepatectomy and sacrificed at various time intervals after irradiation. The administration of 600 r whole-body dose was found to reduce the incorporation of injected thymidine into DNA to 30% of its incorporation into DNA of regenerating liver of nonirradiated animals. This inhibition disappeared progressively as the time lapse between irradiation and partial hepatectomy increased. While the administration of 1000 r 24 hours prior to hepatectomy inhibited DNA polymerase and thymidylic kinase activity in liver supernatant fluid of animals sacrificed 24 and 36 hours after hepatectomy, 600 r inhibited thymidylic kinase activity only. The administration of 1000 r whole-body was without effect on the incorporation of orotic acid-^{14}C into nuclear RNA in vivo and the incorporation of ATP-^{14}C into RNA in vitro. (auth)

33295 CHANGES IN AMINO ACID CONTENT AND INACTIVATION OF LYSOZYME FOLLOWING ULTRAVIOLET IRRADIATION. Umberto Ferrini (Istituto Regina Elena per lo Studio e la Cura dei Tumori, Rome). Arch. Biochem. Biophys., 107: 126-31(July 1964).

Lysozyme in 0.1M KCl solution (degassed) was irradiated with a germicidal lamp (2537 Å). The amino acid composition of samples hydrolyzed by 5.7N HCl and by Streptomyces griseus protease (Pronase) has showed that cystine and histidine residues are affected by ultraviolet light. The close correlation between the rate constants of enzymatic inactivation and histidine loss suggests that the photolysis of this residue is the main factor in the inactivation of lysozyme. The sensitivity of irradiated lysozyme toward trypsin digestion is closely related to the extent of cystine photolysis. (auth)

33296 PERSISTENT POSTIRRADIATION CARCINOMA OF CERVIX UTERI: A PATHOLOGIC STUDY OF 83 PELVIC EXENTERATION SPECIMENS. Carlos Perez-Mesa and Harlan J. Spjut (Washington Univ., St. Louis). Arch. Pathol., 75: 462-74(May 1963).

Effects of irradiation on carcinomatous and normal tissues were studied in extensively excised pelvic tissues from 83 cases of cervical carcinoma in which radiotherapy failed to eradicate the disease. The presence of edema and hyperemia masked the gross recognition of invasive carcinoma in the bladder, changes which were clinically interpreted as irradiation effect; nearly all of the bladders showed evidences of irradiation histologically. Because of the lack of precise dose data the histologic abnormalities from irradiation could not be related to the amount of radiation. In 69 (83%) cases some histologic changes suggestive of effects of ionizing radiation were present in the pelvic organs. A unique radioinduced alteration, seen in 63% of these patients, occurred almost exclusively in small arteries and consisted of intimal masses of large foam cells. Arteries exhibiting these changes were usually in fields of irradiation damage, and most frequently in association with necrosis. The lesion was not necessarily related to arteriosclerosis, but appeared to represent primary damage to endothelium. (TCO)

33297 INDUCTION OF h-MUTATIONS IN THE EXTRACELLULAR PHAGE T2 BY γ-IRRADIATION. S. N. Ardashnikov, V. N. Soyfer, and D. M. Goldfarb (Gamaleya Inst. for Epidemiology and Microbiology, Moscow). Biochem. Biophys. Res. Commun., 16: 455-9(July 27, 1964).

Experiments are reported on induction by γ rays of host-range mutations in extracellular phage T2. The number of radioinduced mutants was higher in all experiments than the spontaneous background. In the region of the dose curve from the beginning to a dose of 140 kR, there was a linear dependence between the dose and the number of mutants. Data on survival and mutability are tabulated. It is concluded that the effects observed must be the result of true induction of mutations under conditions that permitted the direct action of radiation. (H.M.G.)

33298 THE EXCISION OF THYMINE DIMER FROM THE DNA OF uv-IRRADIATED E. COLI 15 T$^-$A$^-$U$^-$ DUR-

ING THYMINE DEPRIVATION. Robert C. Shuster and Richard P. Boyce (Yale Univ., New Haven). Biochem. Biophys. Res. Commun., 16: 489-95(July 27, 1964).

A multiple auxotroph of Escherichia coli requiring thymine, arginine, and uracil was used to determine whether thymine dimers are excised from DNA under conditions of thymine deprivation. Samples labeled with tritiated thymidine were treated in one of the following ways: no uv followed by 60 min incubation in M9 containing no thymine, supplemented with arginine and uracil (–T + AU); uv but no incubation; uv followed by 60 min in –T + AU; uv followed by 60 min in –T – AU; or uv followed by 60 min in –T – AU and then an additional incubation for 2 hr in +T + AU. After centrifugation and treatment with cold 5% TCA, acid soluble and insoluble fractions were separated and hydrolyzed in concentrated trifluoroacetic acid, chromatographed, and scanned for radioactivity. Thymine dimer was identified by its characteristic Rf value and by its reversion to thymine after elution and uv irradiation in aqueous solution. After incubation, photoproducts appeared in the acid soluble fractions resulting in thymine dimer to thymine ratios greater than that found in the insoluble fraction of the irradiated, unincubated control. Results indicated that the breakdown of DNA in irradiated E. coli 15 $T^-A^-U^-$ may be initiated by the excision of fragments containing thymine dimers and that the excision can occur during thymine deprivation and, therefore, in the absence of net DNA synthesis. It appears that the factors responsible for the removal of thymine dimers during incubation in the dark are not subject to the same regulatory mechanisms that control DNA synthesis. (H.M.G.)

33299 RADIATION CARCINOGENESIS. L. F. Lamerton (Royal Cancer Hospital, Sutton, Surrey, Eng.). Brit. Med. Bull., 20: 134-8(May 1964).

Radioinduced carcinogenesis is reviewed in reference to: whether, for different tumor types, there is a relation between susceptibility to radioinduced and spontaneous cancer incidence; and whether, for a given type of tumor, the incidence following irradiation can be matched to that of the unexposed population by change in time-scale or in incidence scale. Topics discussed include: tumor incidence in irradiated human populations; age-dependence relations of radioinduced and spontaneous tumors; susceptibility of embryo and fetus; significance of gross chromosome abnormalities; and theoretical considerations. (H.M.G.)

33300 POLLUTION OF THE ENVIRONMENT BY RADIOACTIVITY. INCIDENCES OF RADIOCONTAMINATION OF THE BIOLOGICAL CYCLE. Colonel Bocquet. Cahiers Med. Vet., 31: 1-51(July-Aug. 1962). (In French)

The radiocontamination of the environment is discussed from the viewpoint of the problems it presents to the veterinarian. The types of ionizing radiations are briefly classified, and their effects are summarized. The sources of natural and artificial radioactivity are indicated. The contamination of the biological cycle is reviewed. In conclusion, the role of the veterinarian services in the study and prevention of radiocontamination is discussed. (J.S.R.)

33301 POTASSIUM LEVELS IN REGENERATING RAT LIVER. D. K. Myers (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Biochem. Physiol., 42: 1111-14(July 1964). (AECL-1961)

The livers of female rats were irradiated with a 300 kv x-ray machine at a dose rate of 300 R/min. Livers of control rats were surgically removed. All animals were allowed food and water ad libitum until death by decapitation. Protein and hemoglobin concentrations were determined in homogenates of livers removed from the rats. It was concluded that: potassium levels in rat liver do not change significantly during liver regeneration; prolonged perfusion of rat liver can lead to appreciable loss of intracellular potassium; and the inhibitory effects of x irradiation on cell division and DNA synthesis in regenerating liver are not associated with a loss of intracellular potassium. (H.M.G.)

33302 SOMATIC MUTATIONS IN CARNATIONS INDUCED BY GAMMA RAYS. F. D'Amato, E. Moschini, and L. Pacini (Università, Pisa and Centro Sperimentale di Floricoltura, Pescia, Italy). Caryologia, 17: 93-101(Jan.-Apr. 1964). (In Italian)

Rooted cuttings of the carnation varieties Cardinal Sim and Elia rosso, both with semidouble flowers, were irradiated with 7,500 and 10,000 r of gamma rays from ^{60}Co. In R_1, in addition to physiological changes, various types of mutations—which were propagated in vR_2 and vR_3—were observed. The number and percentage of plants showing mutations are reported. In Cardinal Sim (original color: Orient Red 819-819/1, Wilson) only one plant with a white mutation was found; in Elia (original color: Geranium Lake 20-20/1) mutations occurred for: Rose Opale, Peach, white with a central red stripe in each petal and white-variegated red. As already observed by Sagawa and Meilquist (1957), most color changes appeared in a chimeric condition in the branches. In addition to the occurrence of simple flowers (5 petals and normal looking anthers) in three R_1 plants, several cases of flowers with a petal number lower than the semidouble control were found both in Cardinal Sim and Elia. In Cardinal Sim, a few plants showing flowers with an increased number of petals as compared with the control were observed (low and high petal numbers could be propagated in vR_2). This suggests the possibility that the character number of petals in the material is controlled by a polygenic system. In Elia, it was observed that flowers with a reduced number of petals (mean number about 17, as opposed to about 34 in the control) were sometimes characterized by a long slender calyx. Whether this situation is due to a pleiotropic effect or to a contemporary occurring second mutation is as yet unknown. Chlorophyll deficient sectors (yellow-greenish and albino) were induced. Wholly mutated plants obtained in the following vegetative propagations were unable to survive. Waxless sectors were found in some R_1 plants. Depending on size of the mutated sector in R_1, wholly mutated plants could be obtained in vR_2 or in vR_3. (auth)

33303 PRIMARY EFFECTS OF DIFFERENT MUTAGENS AND THE DISTURBANCES INDUCED IN THE MEIOSIS OF X_1 AND X_2 OF VICIA FABA. M. V. Ghatnekar (Catholic Univ., Piacenza, Italy). Caryologia, 17: 219-44 (Jan.-Apr. 1964).

The mutagenic effects of x rays, ethylenimine (EI), and ethyl methane sulphonate (EMS) were studied on the small seeded cultivated Swedish variety of Vicia faba. The primary effects of the mutagen on the seedlings emerged and intensity of spotting on the first two leaves indicate clearly that they are dose dependent and increase with the increase in dose concentration. The percentage of survival is also dose dependent. Meiosis of X_1 and X_2 was investigated. Different types of chromosome aberrations observed were briefly reported. A short description of the mutations and morphological deviations observed in the X_1 and X_2 is presented. Besides the usual mutations some other abnormalities such as cytomixis and faulty development of root system were mentioned. These abnormalities are consid-

ered to be effects of the mutagens and interpreted as another type of mutations. Varying degrees of pollen sterility were observed in the X_2. This is interpreted as being due at least partially to non-chromosomic phenomena. It may be due to cytoplasmically inherited male sterility. It is also pointed out that the intensity of spotting in the X_1 as the primary effect of the treatment and the frequency of mutations in the X_2 seem to be independent phenomena. The possibility of utilizing the mutations obtained in the X_2 for further genetic studies and gene analysis of Vicia faba genom were briefly mentioned. (auth)

33304 CHANGES IN THE EFFECT OF PROCAINE UPON THE BLOOD PRESSURE OF RABBITS IRRADIATED WITH 1000 r. Dinh Ky Tranh (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 13: 266(1964).

The effect of procaine remains basically the same in irradiated rabbits as it is in normally healthy ones; however its effect is less pronounced. Also the death rate in animals that were given procaine was decreased when irradiation was administered. (OTS)

33305 INFLUENCE OF X-RAY RADIATION IN VITRO UPON THE FORMATION OF OXIDATION PRODUCTS OF LIPIDS IN THE HOMOGENATES OF LIVER, KIDNEYS, AND THE INTESTINE OF RATS. K. Lejsek and B. Zicha (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 13: 266-7(1964).

X radiation of 600 r at pH 5.9 showed no influence on the formation of oxidation products in rats. Doses of 5000 and 10000 r at pH 5.9 inhibited formation of the oxidation products. (TCO)

33306 INFLUENCE OF PHYSOSTIGMINE UPON IRRADIATED RATS. V. Grossmann, J. Tulach, O. Horackova, O. Ochrymovic, and O. Peca (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 13: 268(1964).

Physostigmine in doses of 200 micrograms per kg of body weight was administered and a dose of irradiation of 600 r was used. In irradiated animals the activity of cholinesterase was influenced to a lesser degree than in a control group. (OTS)

33307 RADIOSENSITIVE FACTORS OF CELLULAR PROLIFERATION. M. Silha and L. Zemanova (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 13: 274-5(1964).

The influence of irradiation upon the factor stimulating growth was investigated. Experiments with rats indicated that a dose of 700 r 20 hours after irradiation showed a definite influence. (OTS)

33308 THE CONDITION OF LIBERATION OF DESOXY-RIBO-POLY-NUCLEOTIDES FROM IRRADIATED TISSUES. M. Skalka, J. Matyasova, and V. Chlumecka (Inst. for Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 13: 274(1964).

Liberation of polydeoxyribonucleotides was noticed at a level of 25–50 r and up to 300 r the influence was in a direct linear proportion. The liberation started after 2 hours, and reached a maximum after 4–6 hours. Lymphatic and blood forming cells are subject to this phenomenon. It is a process that can be detected only in vivo; experiments in vitro were unsuccessful. (OTS)

33309 COMPARISON OF THE EFFECTS OF IRRADIATION AND OF NUCLEIC ACIDS UPON CHROMOSOMES. Z. Karpfel and J. Slotova (Inst. for Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 13: 275(1964).

Experiments were conducted on mice; intraperitoneal injections of nucleic acids caused chromosome aberrations comparable with those effected by irradiation. The minimum dose of nucleic acid was 0.05 mg per mouse. 0.2 mg corresponds in its effect to 10–15 r. (OTS)

33310 RELATION BETWEEN THE RADIORESISTIVITY OF BACTERIA AND THEIR CONTENT OF NUCLEIC ACIDS AND PROTEINS. B. Liska and M. Vizdalova (Inst. for Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 13: 275(1964).

Studies were made on Bacterium Coli, strain B, grown under aerobic conditions. Connections between the age of the culture, contents of nuclei acids and proteins, and the resistivity to radiation are discussed. (OTS)

33311 COMPARATIVE EFFECT OF HYDROCORTISONE AND X IRRADIATION ON THE LEUKEMOGENESIS OF AKR MICE. J.-F. Duplan (Institut du Radium, Paris). Compt. Rend. Soc. Biol., 158: 228-30(1964). (In French)

Male and female AKR mice, 40 days old, received on 6 successive days an intramuscular injection of hydrocortisone. At the age of 65 ± 5 days they were exposed to 800 R of x radiation, and 18 hrs later they received an intravenous injection of 10^7 cells of isologous bone marrow from normal donors. After spontaneous death, each mouse was autopsied and the existence of leukemia investigated. The results are tabulated to show the length of survival and the number of leukemias. Hydrocortisone and x radiation affect leukemogenesis in very distinct ways. The first modifies the latency of the leukoses and the second modifies their frequency. There are strong sexual differences in the effects of the two agents. Hydrocortisone alone lengthens the average life of both sexes, but irradiation decreases the number of leukemias more in the males than in the females. (J.S.R.)

33312 STUDY OF THE DESCENDANTS OF RATS IRRADIATED AT A YOUNG AGE. A. Léonard, J. R. Maisin, and L. Malfait (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Compt. Rend. Soc. Biol., 158: 391-5(1964). (In French)

The first observations on the first, second and third generations of rats exposed to 50, 150, 300, and 500 R eight or seventeen days after birth are reported. The irradiation caused the appearance in the descendants of a certain number of abnormal individuals (microcephalia, anencephalia, and cataracts). There was a high mortality in the descendants between birth and weaning in the F_1 generation. A percentage of normally built individuals have below-normal size and weight. These small individuals have a decreased fertility. This dwarfishness seems, to a certain extent, to be transmittable to descendants. (J.S.R.)

33313 FEASIBILITY OF PRODUCING F_1 HYBRID COTTON SEED THROUGH RADIATION-INDUCED POLLEN STERILITY. M. J. Constantin (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Crop Sci., 4: 299-302 (May-June 1964).

Dormant seeds (11% moisture) of 3 American upland cotton varieties, Deltapine Smooth Leaf, Empire W. R. 61, and Pope, were exposed to 0, 5, 10, 20 or 40 kr of gamma-radiation. Response of all varieties to seed irradiation was comparable. The following responses were observed: M_1 seedling survival was not affected, yield of seed-cotton was reduced severely by the two highest radiation treatments, outcrossing was increased from 28% in the controls to 42% and 48% in the 20 kr and 40 kr populations, respec-

tively, and M_2 seedling survival decreased from 56% in the controls to 36% at 40 kr dose. The increase in percent outcrossing, due probably to radiation-induced pollen sterility, was more than offset by the severe decrease in seed-cotton yield and M_2 seedling survival. Therefore, on the basis of this experiment, it was considered impractical to recommend seed irradiation as a means of producing large quantities of F_1 hybrid cotton seed. (auth)

33314 EFFECT OF GAMMA-IRRADIATION OF SEEDS ON EXTRACTS OF CELLULAR STRUCTURES OF SUGAR BEET LEAVES. P. A. Vlasyuk, O. D. Kolomiets, and L. P. Vitkalenko (Inst. of Plant Physiology, Ukrainian SSR). Dopovidi Akad Nauk Ukr, RSR, No. 5, 678-82(1964). (In Ukrainian)

Spectrophotometric investigations of aqueous, salt, alkaline, and alcohol extracts of the cellular structures of the leaves of one-month sugar beet plants, grown from seeds irradiated with doses of 500 and 2500 R were conducted. It is shown that on irradiation of sugar beet seeds with gamma rays there occurs a change in the biochemical processes connected with synthesis of proteins, which is characterized by a sharp rise in the optical density of the extracts of cellular structures with large doses of irradiation. (auth)

33315 FIELD MEASUREMENTS OF CARBON DIOXIDE EXCHANGE BY PINUS RIGIDA TREES EXPOSED TO CHRONIC GAMMA IRRADIATION. P. F. Bourdeau and G. M. Woodwell (Brookhaven National Lab., Upton, N. Y.). Ecology, 45: 403-6(1964). (BNL-7054)

Rates of CO_2 absorption in Pinus rigida trees exposed to chronic gamma irradiation were depressed during midwinter and recovered during the spring. Net photosynthesis occurred at low rates throughout the winter when light intensity was high and air temperature in the chambers was within 1-2°C of freezing or higher. Irradiation first reduced rates of CO_2 absorption to low but positive levels which persisted briefly until the leaves lost chlorophyll and turned brown. Trees exposed at 1,300 r/day succumbed after the total exposure to more than 120,000 r, while trees exposed to 30 r/day succumbed after about 6,300 r. The processes involved in CO_2 exchange are apparently resistant to short-term damage from chronic exposures in the range of 30 to 1,300 r/day, and measurement of CO_2 exchange is not a sensitive technique for measurement of radiation damage to plants. (auth)

33316 EFFECT OF LOCAL IRRADIATION ON TESTICULAR ANDROGEN BIOSYNTHESIS. Edgar J. Schoen (Kaiser Foundation Hospital, Oakland, Calif. and Univ. of Utah, Salt Lake City). Endocrinology, 75: 56-65(July 1964).

Testicular irradiation sufficient to destroy the germinal cells in rats left the interstitial cells morphologically intact and able to respond to gonadotropin (HCG) administration by hypertrophy and hyperplasia. However, in vitro, androgen biosynthesis was suppressed in the irradiated testes. The finding that androgen production may be diminished in hypertrophic, hyperplastic interstitial cells indicates that in these cells structure and steroidogenic function are not necessarily correlated, a point that may have clinical significance in such conditions as cryptorchidism, germinal cell aplasia and Klinefelter's syndrome. (auth)

33317 THE INDUCTION OF FORSSMAN-ANTIGEN SYNTHESIS IN HAMSTER AND MOUSE CELLS IN TISSUE CULTURE, AS DETECTED BY THE FLUORESCENT-ANTIBODY TECHNIQUE. Marian Fogel and L. Sachs (Weizmann Inst. of Science, Rehovoth, Israel). Exptl. Cell Res., 34: 448-62(May 1964).

The fluoresent-antibody technique was used to determine whether hamster and mouse cells that are not synthesizing Forssman (F) antigen in vivo can be induced to synthesize this antigen by plating in vitro, and whether different normal and neoplastic cell types can be induced under these conditions. In primary cultures of normal hamster embryos, there was no detectable F antigen in cells spread on the coverslips at one day after cell plating in vitro. After two days the antigen appeared as scattered points in the cytoplasm of some cells, and after three days it was found in nearly all cells. In secondary hamster-embryo cultures, and in cultures made from F-positive tumors, the antigen was already detectable when the cells were examined at one day after plating. The results indicate that F-antigen synthesis after plating primary cultures in vitro were due to antigen induction in cells with originally no detectable antigen, and not due to the selective growth of F-positive cells. Induction occurred even when cell division was inhibited by x-irradiation. Induction of F antigen was also observed both in the epithelial and fibroblast-like cells of hamster kidneys, and in mouse-embryo cells. In contrast to the results with hamsters, a proportion of F-negative cells was found in the mouse cultures even after twelve days in vitro. In the tumor cells, the F antigen was present in seven hamster-embryo clones transformed by polyoma virus (PV) and grown for 3 to 31 weeks in vitro, a hamster-embryo clone transformed by PV in vitro and grown as a tumor in adult hamsters for four months, and a hamster tumor induced by PV inoculation in vivo and transplanted in adult hamsters for about four years. But there was no detectable F antigen in an uncloned population of the hamster tissue-culture line BHK and 4 BHK clones, or after five weeks growth as a tumor in adult hamsters or x-irradiation of one of these clones. The F antigen was also not detected in the mouse tissue-culture line L. In addition to cells that can be induced to synthesize F antigen, and where induction, it is suggested, may be due to a disturbance of the cell-to-cell relationships that control growth in normal tissues, there are thus variants that could not be induced. (auth)

33318 CHROMOSOME SPLITTING AS REVEALED BY COMBINED X-RAY AND LABELING EXPERIMENTS. Sheldon Wolff and H. E. Luippold (Oak Ridge National Lab., Tenn.). Exptl. Cell Res., 34: 548-56(May 1964).

Experiments in which growing roots of Vicia faba were both irradiated to induce aberrant chromosomes and treated with ^3H-thymidine to label those cells that were in the S phase of the cell cycle have shown that the chromosomes react to radiation as though double in G2 and S and as though single during most of G1. The transition period when the chromosome changes from reacting as though single to double seems to occur in late G1 before DNA synthesis takes place. The resolution of the method, however, is only good enough to allow the statement that the chromosome becomes double to radiation either before S or in very early S before much DNA is duplicated. (auth)

33319 EFFECTS OF BROMIDE ON SECRETORY AND SITUATIONAL CONDITIONED REFLEXES IN HEALTHY AND X-RAY IRRADIATED DOGS. O. N. Voevodina (Inst. of Experimental Medicine, Leningrad). Farmakol. i Toksikol., 26: 145-9(1963). (In Russian)

Healthy dogs given doses of 0.15 to 0.25 gm bromide showed improvement in situational and secretory con-

ditioned reflexes. Irradiation one year before introduction of bromide showed digressions from the normal course of situational and secretory conditioned reflexes for a period of 14 days after single introduction of the drug. The spatial situational conditioned reflexes became deranged first. Latent periods were lengthened as motor conditioned reflexes also were. These disturbances involved the differentiation faculty too. Changes arising under the influence of bromide resemble very closely those noted in a symptom complex which developed in the body of dogs under the immediate effect of x-rays in doses from 15 to 320 R. The digressions in the course of both secretory and situational conditioned reflexes appearing subsequent to the effect of bromide may be seen in irradiated dogs after a lapse of a lengthy period of time (over one year) since the actual irradiation. (auth)

33320 DISEASE OF SUBLETHALLY IRRADIATED F_1 HYBRIDS AFTER ADMINISTRATION OF PARENTAL LYMPHOID CELLS. K. Nouza (Inst. of Experimental Biology and Genetics, Prague). Folia Biol. (Prague), 10: 212-31(1964).

The disease of sublethally irradiated (A × CBA)F_1 and (A × C57B1)F_1 hybrids following the transplantation of parental bone marrow and spleen cells is described. After irradiation with 450 R, only spleen cells caused disease and death of the recipients. The pathogenic capacity of the two parental strains was not identical. After irradiation with 550 R, most of the spleen cell recipients and some of the bone marrow cell recipients died. The clinical and pathological anatomical picture of the disease is described. Changes in the peripheral blood picture and the cellularity of the bone marrow and spleen were analyzed over a given period in (A × C57B1)F_1 hybrids irradiated with 450 R to which C57B1 spleen cells were transplanted and were compared with changes in control hybrids which were only irradiated with 450 R. Cytological studies of the bone marrow and spleen during the observation period showed that the process took place in several phases. In the first phase the spleen and bone marrow of experimental animals were richer in cells than those of the controls, evidently as a result of proliferation of donor cells promoting regeneration of lymphopoiesis and hematopoiesis. In the next phase the picture in the bone marrow and spleen returned to normal, while severe aplasia of both organs developed in the experimental animals. This was preceded by the proliferation of lymphoid cells whose origin could not yet be determined. This disease of sublethally irradiated F_1 hybrids following the transplantation of parental lymphoid cells is a convenient, simple, and reliable model of the graft-versus-host reaction, but it comprises a number of subsidiary reactions which it may prove possible to explain more exactly in the course of therapeutic studies. (auth)

33321 PREDICTION OF INDIVIDUAL DIFFERENCES IN RADIOSENSITIVITY IN MICE: TESTICULAR ATROPHY, MORTALITY AND WEIGHT CHANGES. M. Pospíšil and Y. Ueno (Inst. of Biophysics, Czechoslovak Academy of Sciences. Brno and Kyoto Univ.). Folia Biol. (Prague), 10: 232-8(1964).

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ditioned reflexes. Irradiation one year before introduction of bromide showed digressions from the normal course of situational and secretory conditioned reflexes for a period of 14 days after single introduction of the drug. The spatial situational conditioned reflexes became deranged first. Latent periods were lengthened as motor conditioned reflexes also were. These disturbances involved the differentiation faculty too. Changes arising under the influence of bromide resemble very closely those noted in a symptom complex which developed in the body of dogs under the immediate effect of x-rays in doses from 15 to 320 R. The digressions in the course of both secretory and situational conditioned reflexes appearing subsequent to the effect of bromide may be seen in irradiated dogs after a lapse of a lengthy period of time (over one year) since the actual irradiation. (auth)

33320 DISEASE OF SUBLETHALLY IRRADIATED F_1 HYBRIDS AFTER ADMINISTRATION OF PARENTAL LYMPHOID CELLS. K. Nouza (Inst. of Experimental Biology and Genetics, Prague). Folia Biol. (Prague), 10: 212-31(1964).

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33333 EFFECTS AND AFTER EFFECTS OF RADIOACTIVE IRRADIATION OF COTTON SEEDS. Sh. I. Ibragimov, V. P. Solov'ev, and P. Paiziev. Khlopkovodstvo, No. 12, 37-41(1963). (In Russian)

Cotton seeds exposed to 500 to 2000 R of gamma radiation resulted in improved and accelerated ripening of the cotton pods and produced a thicker and richer crop. A more powerful second-generation growth with an increased number of pods was observed with seeds exposed to 1500 to 2000 R. The irradiation doses do not affect the length, fineness, and strength of the fiber. (R.V.J.)

33334 RADIOMIMETIC TOXICITY OF OZONIZED AIR. B. Brinkman (Rijksuniversiteit, Groningen, Netherlands), H. B. Lamberts, and T. S. Veninga. Lancet, 1: 133-6 (Jan. 18, 1964).

Reports of similarities between biological effects of ionizing irradiation and those of ozone, including one that demonstrated chromosome breakages in human cell culture, are cited. Previous studies of ozone toxicity have dealt primarily with effects on respiratory mucous membranes; this report summarizes the results of experiments indicating systemic effects of ozone. The phenomenon of sphering of circulating erythrocytes is hastened by x-irradiation in vitro. Erythrocytes from animals or men inhaling as little as 0.2 to 0.25 ppm were more susceptible to this effect. Findings are interpreted as evidence of an ozone effect which penetrates the airways barrier. The rupture of the nuclear envelope of postmitotic nuclei of myocardial fibers of rabbits and mice exposed to 0.2 ppm of ozone 5 hr/day for 3 weeks is reported. A third systemic effect of ozone observed was a higher neonatal mortality in litters of mice from parents exposed to 0.2 ppm of ozone. (Public Health Eng. Abstr., 44: No. 6, 1964)

33335 SPECTRA OF BLOOD SERUM ABSORPTION WITH IONIZING RADIATION AND LOW TEMPERATURE. Yu. K. Ledentsov and E. N. Borodina. Materialy Tret'ego Ural'sk. Soveshch. po Spektroskopii, Inst. Fiz. Metal. Akad. Nauk SSSR, Komis. po Spektroskopii, Sverdlovsk, 1960, 180-2(1962).

Studies were made on the spectra of blood serum absorption in ultra-violet light, total protein content, and relationship between protein fractions of blood under the effect of low temperature and ionizing radiation in rats. It was established that there is reduced intensity of absorption under the effect of x rays on the 7th day after irradiation and under the combined effect of low temperature and irradiation. (Referativnyy Zhurnal, Biologicheskaya Khimiya, No. 20, 1963)

33336 THE ROLE OF HEREDITARY AND CHROMOSOMAL DISEASES DURING THE ANALYSIS OF GENETIC SEQUELAE OF RADIATION. E. F. Davidenkova and I. I. Shtilbans (Inst. of Oncology, Academy of Sciences, USSR). Med. Radiol., 9: No. 6, 3-8(June 1964). (In Russian)

When assessing chromosomal diseases in the progeny of irradiated persons one should bear in mind the influence of the mother's age on the number of children with Down's disease. Data on 345 patients with Down's disease show that 52.7% of the children were born of mothers over 34 years old, whereas in the control group of mothers with normal children there was only 13.3% for the respective age. Subject to consideration also is the type of chromosomal aberrations in Down's disease. (auth)

33337 BONE MARROW TRANSPLANTATION TO IRRADIATED DOGS. I. L. Chertkov, A. S. Maksimenko, M. N. Novikova, and M. O. Raushenbakh (Lenin Inst. of Hematology and Blood Transfusion, USSR). Med. Radiol., 9: No. 6, 8-19(June 1964). (In Russian)

In experiments on dogs subjected to whole-body x irradiation at a dose of 1,000 R, transplanted allogenous bone marrow transformed through the stage of hyperbasophilic cells into lymphocytes. It is shown that mainly the parent hematopoietic cells are subject to transformation. The effect was not associated with the lymphocytes contained in the transplant, since prolonged administration to recipients of large cortisone doses did not reduce the transformation, and introduction of lymphocytes from the peripheral blood lead to the formation of lesser quantities of hyperbasophilic cells in the irradiated dogs. In this instance, the latter formed in the lymphoid tissue and not in the hematopoietic as in bone marrow transplantation. A 4- to 5-day delay of bone marrow transplantation prevented the transformation of the transplant hematopoiesis in a number of dogs and restored the protective effect of bone marrow transplantation in radiation injuries. Reactions of delayed supersensitivity, transplantational immunity, and the effect of allogenous bone marrow transplantation in superlethal irradiation are discussed. (auth)

33338 RADIATION CHANGES IN CRANIAL BONES AS THE RESULT OF ROENTGEN THERAPY OF HYPOPHYSEAL TUMORS. L. G. Matlan (Lvov Field Hospital). Med. Radiol., 9: No. 6, 22-5(June 1964). (In Russian)

Changes of cranial bones in a 50-year-old man are described that were revealed by means of roentgenography after four series of x-ray therapy resulting in a total dose of 20,900 R for chromophobe adenoma of the hypophysis. Radiation changes consisted in the development of osteonecrosis and mild osteosclerosis. The favorable clinical course of these alterations and the effectiveness of radium therapy made it possible to prolong x-ray treatment up to a total dose of 24,950 R. The feature peculiar to this case is the presence of marked radiation changes in the cranial bones without essential radiation injuries to the integument and cerebral tissues. For the radium treatment of hypophyseal tumors the author proposes gamma therapy during which the incidence of radiation complications is minimal. During protracted radium treatment of cerebral tumors it is expedient to institute periodical roentgenographic control over the state of cranial bones. (auth)

33339 PRESACRAL NOVOCAIN BLOCK OF RADIATION INJURIES OF THE RECTUM AFTER RADIUM THERAPY OF UTERINE CERVIX CARCINOMA. V. P. Aizenberg. Med. Radiol., 9: No. 6, 25-8(June 1964). (In Russian)

Sacral novocain block was employed in 22 patients with radiation injuries of the rectum resulting from radium therapy of cervical carcinoma. In two patients with catarrhal rectitis a single block yielded a good effect, in 10 patients with erosive-desquamative rectitis a positive effect occurred only after 2 to 3 blocks carried out with a 5 to 6 day interval, whereas in seven patients with infiltrative ulcerous colitis, 4 to 5 blocks were required for relief of pain. In patients suffering from infiltrative ulcerous rectitis with the formation of a fistula sacral block was of no avail. Presacral block in conjunction with tonics and a proper diet is a simple and effective method of treating radiation injuries of the rectum; the block is well tolerated by patients and provokes no complications. (auth)

33340 THE RELATIONSHIP BETWEEN AFFECTION OF THE SKIN CAUSED BY BETA-RADIATION, THE CONDITIONS OF IRRADIATION AND THE STATE OF THE

SKIN. V. S. Turusov (Inst. of Experimental and Clinical Oncology, Academy of Sciences, USSR). Med. Radiol., 9: No. 6, 28-34(June 1964). (In Russian)

In experiments on albino rats it was shown that in the single action of beta-radiation (radioactive cerium) on the skin the effect of the radiation affection intensifies parallelly with increase of the radiation dose. In fractional irradiation there occurs a weakening of the effect which is greater the lesser the single dose and the larger the interval between the irradiations. In single irradiation complete stable epilation develops only at the site of former ulcerous lesions, whereas in fractional irradiation there was observed a complete and stable epilation in conjunction with atrophy of the skin, but without the preceding development of ulcers. (auth)

33341 THE STATE OF THE ACHROMATIC FIELD OF VISION IN PERSONS WORKING WITH IONIZING RADIATION. L. S. Lutsker (Scientific-Research Roentgen-Radiological Inst., Ministry of Public Health, USSR). Med. Radiol., 9: No. 6, 34-43(June 1964). (In Russian)

The state of the achromatic field of vision was investigated in 408 persons subjected to the effect of ionizing radiation and in 142 persons of the control group. In 51 persons having contact with ionizing radiation there was seen a narrowing of peripheral limits, in individual cases also paracentral relative scotoma. Among this group in 30 persons as the result of clinical examination and dosimetric data the author revealed signs of the effect of radiation on the organism. Alteration of the field of vision in respect to white color, in the absence of changes in the fundus oculi, indicates an affection of the central neuron of the optic tract, this being confirmed by electroencephalograms pointing to the presence of functional lesions in the cerebral cortex (occipital, temporal, frontal and parietal regions). As the result of statistical treatment of the data obtained the author assumes the relation between narrowing of the limits of the achromatic field of vision and the irradiation dose of the organism due to a degree of narrowing of the limits of the field of vision and the value of the irradiation dose, and the absence of relation between the limits of the field of vision and the period of work with ionizing radiation, as well as the age of the examinees. (auth)

33342 THE REMOTE SEQUELAE OF AFFECTION OF DOGS WITH Sr^{90}. I. K. Petrovich, N. O. Razumovskii, and O. L. Torchinskaya. Med. Radiol., 9: No. 6, 48-50(June 1964). (In Russian)

In a number of animals (approximately 30%) in remote periods following single intravenous administration of ^{90}Sr osteosarcoma does not develop, but there occurs dystrophy of parenchymatous organs and emaciation of the skeletal musculature. Toxicological data and the dynamics of hematopoietic changes enable to conclude that in remote periods of life of animals affected with ^{90}Sr the hematopoietic alterations depend upon the state of parenchymatous and endocrine organs. (auth)

33343 THE EFFECT OF X RADIATION AND HYDROGEN PEROXIDE ON THE POTENTIAL DEVELOPMENT OF ISOLATED RETINA. P. Dettmar (Universität, Leipzig) and G. G. Demirtschoglian. Naturwissenschaften, 51: 269-70(1964). (In German)

The behavior of the electroretinogram of isolated retinas after x radiation was investigated. The frog retina was exposed to doses up to 10,000 R, and its electrical response to light stimulus was compared with that of nonirradiated controls. No variation in height and shape of the retinogram was detected. The retinas placed in hydrogen peroxide solution showed, in their response to light, modifications in the retinal processes. (J.S.R.)

33344 EFFECTS OF X IRRADIATION ON THE HEMOPOIETIC FUNCTION OF FETAL LIVER OF THE MOUSE. J. F. Duplan (Institut du Radium, Paris). Nouvelle Rev. Franc. Hematol., 3: 121-31(Jan.-Feb. 1963). (In French)

Fetuses of mice were given a single irradiation of 240, 580, or 960 R on the 13th to 16th day of intra-uterine life and were killed 24 hours to 5 days after the exposure, using a technique that permitted irradiation of a single fetus at a time. This prevented any maternal damage that might affect the fetus while supplying controls of the same litter. A study of the changes in the weight and of hemopoiesis in the liver showed that the 14th day of intra-uterine life is the time at which the hemopoietic tissue in the liver of mice is most radiosensitive. The liver cells themselves are probably most sensitive on the 13th day, but certainly they are so before the 15th day. In general, the intrahepatic hematopoietic tissue of the fetus appears to be less radiosensitive than the blood-forming tissue of adults. This difference depends upon the fact that some fetal hematopoietic cells are at a radioresistant stage of development; the symbiosis of the fetus with the maternal organism, which protects it from radiations; and the fact that the fetus is protected against bacterial infections consequent upon irradiation. (auth)

33345 HEMOLYSIS BY IONIZING RADIATION: ENZYMATIC CHANGES IN ERYTHROCYTES AND PROTECTIVE EFFECTS OF SOME SUBSTANCES. G. G. Nenci and A. Gubbiotti (Università, Perugia, Italy). Nuntius Radiol., 29: 952-69(Dec. 1963). (In Italian)

The hemolysis and the enzymatic damage produced on the blood in vitro by high doses of radiations from a ^{60}Co source was evaluated. The incubation of the blood irradiated at 37°C for 3 hours markedly potentiates the degree of hemolysis which is almost complete after administration of 700,000 rad, while it is moderate in the samples to which ATP or GSH are previously added; cysteine, glucose, ribose, and adenosine, in decreasing order of importance, showed a lesser protective effect. The enzymatic damage occurring in suspensions in isotonic solution of washed red blood cells, irradiated by 300,000 rad, is important as concerns the G_6PD, GIM, F_6PK, moderate for the PK, aldolase, enolase, and GAPD; unchanged the TIM, MD, PGK, slightly increased the LD. GSH, ATP, and, in lesser degree, glucose partially preserve the enzymes from the damage due to radiations; the GSH shows also a regenerative power on the enzymes, the lesion of which does not seem to represent the only cause of the hemolysis. (auth)

33346 METABOLISM OF C^{14}-TAGGED LYSINE IN CALCIFIED TISSUES DURING ACUTE RADIATION SICKNESS. A. A. Prokhonchukov. Patol. Fiziol. i Eksperim. Terapiya, 7: 81-3(1963).

In experiments on inbred rats of the August strain, certain statistically reliable patterns of changes were demonstrated in lysine (I) metabolism of calcified tissues with acute radiation sickness. A regular and persistent inhibition of (I) metabolism was observed, most pronounced in the femoral bones. Fifty days after irradiation, (I) content in the femoral bones approximates the control, while it continues to remain low in the maxillary bones. Activation of (I) metabolism was observed in the incisors during the first 15 days following irradiation with subsequent inhibition; no essential deviations from the control were detected in the molars. (Referativnyy Zhurnal, Biologicheskaya Khimiya, No. 20, 1963)

33347 EVALUATION OF THE OCCUPATIONAL CHARACTER OF LEUKEMIA IN SUBJECTS EXPOSED TO IONIZING RADIATION. Vladislav Klener. Pracovni Lekar., 16: 170-3(May 1964). (In Czech.)

A survey of experimental data and observations in exposed human communities is presented in order to explain the hazard of leukemia developing in persons chronically exposed to small doses of ionizing radiation. Present knowledge makes it impossible to reach unequivocal conclusions and does not provide the basis for making decisions on work capacity. A uniform procedure is recommended to be established through an agreement between all interested institutions. (auth)

33348 COLPOCYTOLOGICAL VARIATIONS RELATED WITH IONIZING RADIATIONS. V. Gardiol de Bertola (Universidad Nacional de Cordoba, Argentina). Presse Med., 71: 2256(1963).

No alteration of the vaginal cells is the specific response of ionizing radiations. The alterations of the vaginal cells such as protoplasmic vacuolation, phagocytosis, polynucleosis, nuclear alterations and degenerated and odd forms, can be independent of ionizing radiations. On the other hand, cellular enlargement is statistically significant and expresses the epithelial response to ionizing radiations. (Excerpta Med., Sect. XXIII, 1: No. 6 (June 1964))

33349 EFFECT OF IRRADIATION ON NISSL GRANULES IN RAT SPINAL CORD NEURONS—A PILOT STUDY. S. D. Miroyiannis, B. A. Raines, and V. Jurczenko (College of Osteopathic Medicine and Surgery, Des Moines). Proc. Iowa Acad. Sci., 70: 441-53(1964).

Literature concerning the structure and function of Nissl granules and the effect of irradiation on the central nervous system is reviewed. Four groups of rats were irradiated in the lower thoracic spinal region, using doses of 600, 900, 1200, and 4200 R, respectively. Higher doses of the irradiation caused depletion of the Nissl granules and other effects on the nerve cells. Increasing chromatolysis was found with increasing doses of irradiation. These findings warrant further study. (auth)

33350 THE EFFECTS OF 600 ROENTGENS OF X-IRRADIATION ON THE NUCLEI OF MOUSE LIVER CELLS. LaVerne Boldhaupt (Wisconsin State Coll., LaCrosse). Proc. Iowa Acad. Sci., 70: 453-7(1963).

Four methods were employed to detect a change in the parenchymal nuclei of liver cells in 8 week old female A-Jax mice after receiving 600 R of localized x irradiation. These methods were: determination of the percentage of parenchymal cell volume made up of nuclear material by means of the Chalkley point ratio method; estimation of the actual nuclear volume by means of camera lucida drawings; estimation of the number of nuclei per cc of tissue; and estimation of the ploidy distribution of the nuclei as inferred from nuclear volumes. Irradiated and non-irradiated mice were sacrificed immediately, in 6 hours, 12 hours, 18 hours, 24 hours, 48 hours, and 72 hours following x irradiation. No significant difference was noted between the irradiated and between the non-irradiated nuclei from one time of sacrifice to the next. When the data from all times of sacrifice were combined, no significant change attributable to radiation damage was noted in the nuclei. (auth)

33351 CELLULAR ASPECTS OF THE MAMMALIAN RADIATION SYNDROME: NUCLEATED CELL DEPLETION IN THE BONE MARROW. Theodore T. Puck (Univ. of Colorado, Denver). Proc. Natl. Acad. Sci. U. S., 52: 152-60(July 1964).

Experiments were performed to test whether the depletion of nucleated cells in the bone marrow of irradiated mice follows a course predicted by the theory that reproductive inhibition alone is operative, or whether a radio-induced acceleration of cell removal processes also makes a substantial contribution. Nucleated cell interconversions could be ignored in these experiments, and conditions were used that would minimize or eliminate effects of reversible mitotic lag. The data indicated that the rate of cell depletion is immeasurably low at 24 to 33 rads, becomes detectable at 48 rads, and reaches a maximum rate at about 190 rads, which is maintained without alteration, even up to doses close to 2000 rads. The behavior failed to indicate any measurable contribution by accelerated removal processes induced by the radiation. The effective half life for the population of nucleated cells in the bone marrow of 6-week-old, Swiss female mice was calculated to be 10.8 ± 3.4 hr. (auth)

33352 EFFECTS OF Ce^{144} ADMINISTERED TO PREGNANT RATS. A. F. McFee (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Proc. Soc. Exptl. Biol. Med., 116: 712-15(July 1964).

Single oral doses of 0.5 and 1.0 mc of ^{144}Ce were delivered to female rats on days 4 through 14 of gestation. High embryonic resorption rates resulted in markedly reduced numbers of young among those dosed between 4 and 9 days. Doses of 0.5 mc were damaging in this early period although less so than the higher level. Doses administered later than day 9, caused fewer embryonic deaths than those given earlier in pregnancy. The only physical defects noted in significant numbers among surviving progeny were those affecting the eyes in litters dosed on days 7, 8, or 9. No definite effect on growth rate of the offspring could be ascertained and only moderate changes in testis histology following 13- or 14-day doses. (auth)

33353 ELECTROPHORETIC PATTERNS FROM X-IRRADIATED BLOOD SERUMS. Anthony J. Luzzio (Army Medical Research Lab., Fort Knox, Ky.). Proc. Soc. Exptl. Biol. Med., 116: 769-74(July 1964).

Rat, rabbit, and human blood sera, when analyzed by paper electrophoresis, showed marked changes after they had been irradiated in vitro at 6 dose levels from $10^{6.07}$ to $10^{6.48}$ r. In general, as the dose of x radiation was increased, the percent of albumin and gamma globulin in the total protein decreased as alpha and beta globulins increased. It is suggested that perhaps albumin and gamma globulin molecules are so altered by irradiation that they become electrophoretically indistinguishable from alpha and beta proteins. Similar changes occurred 2 to 7 days after irradiation when rabbits were given doses of 750 r to 5000 r. Differences between types of sera as a result of in vitro irradiation were: less pronounced increases in the $alpha_2$ and beta globulins for the human serum than for the others, a more marked increase in the $alpha_1$ globulin of human plasma than for the other sera tested, and a more marked decrease in the albumin fraction of the rat serum than of the other sera tested. (auth)

33354 STUDY OF THE BIOLOGICAL ACTION OF COSMIC RADIATION UNDER CONDITIONS OF COSMIC FLIGHTS. N. M. Sisakyan, V. V. Antipov, P. P. Saksonov, and V. I. Yazdovskii. Radiobiologiya, 4: 337-43(1964). (In Russian)

The effect of ionizing radiation on the hereditary structures of cells was studied in various organisms: Drosophila melanogaster, seeds of higher plants, lysogenic bacteria (Escherichia coli), microspores of Tradescantia paludosa,

and others. The studies were carried out on the Sputnik and Vostok flights. At the altitudes of 180 to 320 km, for 1.5 to 96 hr, total radiation doses were 1.5 to 60 mrad, respectively. Ninety percent of the radiation was from cosmic radiation and 10 per cent from the earth's radiation field because of the 65° inclination of the orbit. Slight but statistically significant damage was observed in the hereditary structures of the cells. However, comparison with data obtained in the laboratory indicates that these results are due to the complex effects of vibration, acceleration, and weightlessness as well as to radiation. The type of data obtained were the frequency of dominant and sex-linked recessive lethal mutants in Drosophila, for example. The results are compared with those on human and animal tissues, seaweed, and bacteria carried in Discoverer XVII flights. These organisms received 30 to 35 rads but only the bacteria showed any damage. (TTT)

33355 STATISTICAL MODELS OF POSTIRRADIATION RECOVERY OF CELLS. Yu. G. Kapul'tsevich and V. I. Korogodin (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 4: 349-56(1964). (In Russian)

Statistical models of postirradiation recovery of cells were examined, on the plots of which a principle of strike was based. Different types of recovery were shown to require different variations in the proportions of the types of cell inactivation and different dependences of the effective dose on time. The radiobiological characteristics of cells corresponding to the different models are tabulated, showing the type of dependence of integrated dose on time and initial dose for several relations of inactivation types. The aftereffects of individual strikes and the individual strikes are taken as the elementary units of recovery. The clearest differences are in models with which recovery can be described in terms of the effective dose. Therefore the first step in choosing a statistical model that may be used for describing experimental data should be analysis of the changes in the ratio of the types of inactivation of irradiated cells during the recovery process. The recovery curve must be analyzed according to the initial dose. In using these models for analyzing experimental data, it must be remembered that only the reversible component of the radiation damage to the cell is calculated. (TTT)

33356 DAMAGE TO THE DNA STRUCTURE IN VITRO BY LARGE DOSES OF GAMMA RADIATION. V. N. Tokarskaya and G. V. Kondrat'eva (Inst. of Biological Physics, Moscow). Radiobiologiya, 4: 357-9(1964). (In Russian)

Highly polymerized DNA separated from thyroid glands was gamma-irradiated under different conditions with from 2×10^4 to 10^6 R (cesium source) at 700 R/min. The results of determinations of adenine, thymine, guanine, and cytosine and the adenine/thymine and guanine/cytosine ratios showed practically no differences between these values in preparations irradiated dry or in solution and the controls. When dry preparations were irradiated to 200-1000 kR and then dissolved in water, the significant differences in these ratios showed that the DNA had been damaged. This indicates the participation of water in the process causing the damage to DNA. The high radiation sensitivity of DNA to irradiation at 10 kR in seeds by comparison with 10 to 100 kR in preparations indicates the fundamental effects of the biochemical processes in the irradiated cell. (TTT)

33357 CHANGES IN THE SORPTION PROPERTIES OF RAT ADRENAL TISSUES AFTER GAMMA IRRADIATION. E. G. Dolgov (Semipalatinsk Medical Inst., USSR). Radiobiologiya, 4: 367-9(1964). (In Russian)

Experimental studies were done on the changes in the physiological state of the adrenals of rats during development of acute radiation damage. Rats (100 total, 25 controls) of both sexes, weighing 165 to 200 g were gamma irradiated with a ^{60}Co source to doses of 400 or 800 R. At times from 6 hr to 5 days after irradiation the animals were decapitated and the adrenals were removed and placed first in Ringer's solution for 20 to 30 min and then in 0.01% neutral red made up in Ringer's solution without soda. The dye was subsequently extracted and determined colorimetrically. The adrenals of animals irradiated with 400 R showed no change in absorption after 6 hr. There was then a regular decrease at 1 and 2 days, but on the third day values were the same as for the controls, and at 5 days they were higher. In the 800-R series, low absorption at 6 hr, 2 days, and 5 days and higher values at 1 day and 3 days were found. Thus, the changes in the sorptive properties of the adrenals are cyclic and depend on the severity of the radiation damage. They reflect the dynamics of the changes in the functional state of the adrenals after the action of ionizing radiation on the organism. (TTT)

33358 CHANGES IN SORPTION PROPERTIES OF BRAIN AND KIDNEY TISSUES UNDER THE INFLUENCE OF SMALL DOSES OF RADIOACTIVE FISSION PRODUCTS OF ^{235}U. A. K. Yukhlov and R. A. Knyazeva. Radiobiologiya, 4: 370-4(1964). (In Russian)

Radioactive fission products of ^{235}U were introduced to the stomachs, through the mouths, of female white mice; 0.01 and 1 μC per kilogram of animal weight. Seventy-five animals were treated (35 controls) all weighing between 19 and 25 g initially. After 12 to 90 hr the animals were decapitated and the brains and kidneys were placed in Ringer's solution for 20 min and then in 0.01% neutral red made up in Ringer's without soda. The dye was subsequently extracted and determined colorimetrically. Dye sorption by the brain tissue of the animals in the 0.01-μC group increased slightly up to 30 hr and then fell to slightly below normal at 84 hr. In the 1-μC group there was a decrease at 12 hr to 25% below normal but then a rise to 25% above normal at 36 hr, with a subsequent fall at 60 hr to almost normal. Kidney sorption properties for the 0.01-μC group followed a similar pattern. However, for the 1-μC group it rose at 12 hr to a level 75% above normal and then fell to 40% above normal at 60 hr. In similar experiments with uranium salts without fission products, no changes in brain or kidney sorption were seen. The microscopic changes in the stained kidney cells of the 1-μC group were similar to nephritic. (TTT)

33359 DECOMPOSITION OF HISTIDINE IN LIVERS OF MICE SUBJECTED TO IONIZING RADIATION. A. P. Safronov and T. N. Protasova. Radiobiologiya, 4: 375-7 (1964). (In Russian)

Male white rats weighing 180 to 220 g (82 experimental and 11 controls) were irradiated (cobalt-60) at 300 R/min to a total of 700 R (96 to 98% mortality in 10 to 12 days). At intervals up to 10 days the animals were decapitated, the livers were sectioned and incubated with histidine, and free histidine was subsequently determined. Decomposition of the histidine was maximum on the third day, more than twice that in unirradiated animals, and on the tenth day it was still 80% higher than normal. The results indicate that histidine decomposition may lead to early radiation damage. The change in histidine metabolism is apparently related to the overall picture of nitrogen balance characteristic for radiation pathology. The results are compared with those from other work in which similar increases in the decomposition of tryptophane and tyrosine were shown.

The mechanism of decomposition of the aromatic amino acids under the influence of radiation is not clear, but it is possibly connected with the effects of peroxide compounds that accumulate in organs and tissues of irradiated animals. (TTT)

33360 CHANGE IN COMPOSITION OF THE LIVER LIPID FRACTION OF IRRADIATED ANIMALS. V. A. Gromov, Z. I. Zhulanova, E. F. Romantsev, D. D. Smolin, and G. N. Sokolova. Radiobiologiya, 4: 378-80(1964). (In Russian)

Male white mice weighing 18 to 22 g were whole-body-irradiated with ^{60}Co radiation for 2 min at 350 R/min. The animals were decapitated 60 sec later, the livers were removed, and the lipid was extracted and analyzed. Separate lipid fractions were gamma-irradiated in vitro in air to 32×10^4 and 32×10^5 R. As a result of the irradiation of the animals, peroxide-like compounds in the neutral-fat fraction increased markedly, but no such compounds were detected in the phospholipid fraction. In the in vitro irradiations of dry samples, with both doses the peroxide-like compounds increased in the neutral fat and oleic acid but not in the phospholipid fraction. The formation of peroxide-like compounds is an established fact and is here suggested to be one of the early biochemical reactions in radiation damage since these compounds appeared 1 min after the irradiation. It is suggested further that the formation of the peroxide-like compounds in the neutral fat fraction is related to the oxidation of unsaturated fatty acids in the triglycerides. The method used for chemical analysis was that of reaction with 2,6-dichlorophenolindophenol. (TTT)

33361 DESOXYRIBONUCLEASE ACTIVITY OF TISSUES AT DIFFERENT STAGES OF RADIATION DAMAGE. I. P. Moskalenko (Inst. of Medical Radiology, Khar'kov). Radiobiologiya, 4: 381-3(1964). (In Russian)

Male white rats weighing 150 to 180 g were irradiated with the bremsstrahlung beam of a linear accelerator with a maximum intensity of 3.5 Mev and an effective maximum of 0.6 Mev at an average rate of 500 R/min. The experimental error of the dose was ±10%. The desoxyribonuclease activity of the spleen and of the bone marrow was studied at 1 min, 1 hr, and 24 hr after irradiation to 268, 825, and 1240 R. For the 280-R-irradiated group, the enzyme activity was somewhat higher than normal in both tissues at all three times of examination, and the increase was marked when lethal doses (825 and 1240 R) were used. At 1 min the activity was nearly twice as high in the bone marrow and about 50% higher in the spleen for the 825-R-irradiated animals. For the 1240-R group, after 1 hr the activity values were more than twice and about 75% higher than in the marrow and spleen, respectively. After the 24-hr period after irradiation, there was a tendency in some cases for the values to return to normal. (TTT)

33362 PROTEOLYSIS OF THE BLOOD OF RATS IRRADIATED WITH IONIZING RADIATION. Yu. P. Druzhinin and V. N. Benevolenskii. Radiobiologiya, 4: 384-7(1964). (In Russian)

Male rats, 67 weighing 120 to 140 g in the first series and 39 weighing 190 to 210 g in the second series, were whole-body irradiated with x rays to 0.75–1600 R. Blood was taken from the tail and analyzed before and at 2-hr to 30-day intervals after the irradiation in the first series and after 7 days in the second. Data obtained in the first series showed that proteolysis is significantly higher at 6 hr, 3 days, and 7 days after irradiation. For each dose there were two proteolysis peaks, the time of appearance of which depended on the dose. With low doses, 0.75 to 6 R, these peaks occurred on the third and seventh days; for the 12.5-R group, the peak on the seventh day almost disappeared, but there was a new peak at 6 hr which increased at the 400- and 800-R doses. With the 0.75-R dose there was a statistically significant decrease in the proteolytic activity in the first two days. With a 1600-R dose, changes in proteolysis were not observed. In the second series, only one increase, on the seventh day for the 3- and 6-R groups and on the fifth day for the 12.5-R to 400-R groups, was seen. At 0.75, 1.5, 800, and 1600 R there was no change in the proteolytic activity of the blood. It is suggested that the observed peaks are reflections of the reaction of different organs. (TTT)

33363 CHANGES IN THE PERIPHERAL BLOOD ON IRRADIATION OF DIFFERENT PARTS OF THE ANIMAL WITH LARGE DOSES. N. I. Shmeleva (Central Scientific Research Inst. of Medical Radiology, Leningrad). Radiobiologiya, 4: 388-90(1964). (In Russian)

Guinea pigs (280), weighing 300 to 350 g, were whole-body-irradiated to doses of 400 R and 2 and 10 kR or head- or trunk-irradiated to 10 kR at 100 R/min. The leukocytes, erythrocytes, and hemoglobin contents and the formed elements of the peripheral blood were studied. In the 400-R group, 50% of the animals died in 30 days. At 1 hr after irradiation the leukocyte counts fell to 45%, at 3 hr they returned almost to normal, and at 24 hr they fell again, the resulting leukopenia lasting 5 to 7 days. The 2-kR group reacted similarly except that the rise at 3 hr was much less, and all animals died at 5 to 7 days. In the 10-kR group the drop at 1 hr was only slight, the rise continued to about 6 hr, when it was nearly twice normal, and then it fell. The animals of the last group died at 18 to 36 hr with typical symptoms of acute radiation sickness. At 1 hr the leukocyte level was 200% of normal, at 6 hr it had fallen to about 175%, but was 200 to 220% at 24 hr and until death in the animals whose heads only were irradiated. The trunk-irradiated animals did not develop acute symptoms and reacted in the same manner as the 2-kR whole-body irradiated group. (TTT)

33364 CHANGE IN THE FUNCTIONAL STATE OF THE CARDIO-VASCULAR SYSTEM IN RABBITS CHRONICALLY IRRADIATED WITH SMALL GAMMA DOSES. S. A. Keizer, K. V. Ivanov, and M. V. Zhukov. Radiobiologiya, 4: 391-5 (1964). (In Russian)

Twenty-nine rabbits were used in the experiment; 17 (12 controls) were gamma-irradiated daily with a dose of 0.05 R for up to 21 months. Measurements made over this time showed no great changes in the pulse rate or arterial pressure. After 6 months, there was a decrease in some of the EKG waves. Under special stress conditions, after 7 to 21 months of the experiment, more than half the animals showed a more rapid pulse rate, while the controls under the same conditions showed a lower rate or no change at all. Pressure on the eyeball of the control animals did not change the frequency of the heart contractions; in the irradiated animals there was an increase in the pulse rate at 13 months in about half the animals, but at 21 months this was not observed. In the irradiated animals pressure on the eyeballs caused a sinus arrythmia more often than in the controls. There was a more noticeable vessel lability in the irradiated animals than in the controls, and vessel spasm was more prolonged. The data are presented in detail in tabular form. (TTT)

33365 ENERGY BALANCE AND PREDICTION OF RADIATION SENSITIVITY IN RATS. M. Pospishil, L. Novak, and B. Goshek (Inst. of Biophysics, Czechoslovak Academy

of Sciences, Brno). Radiobiologiya, 4: 396-401(1964). (In Russian)

Twenty male rats, Wistar strain, 50 to 63 days old, were used in the experiments. Eight hours before irradiation, the animals were placed in glass metabolism chambers and the oxygen and carbon dioxide were measured. They were then irradiated to a total dose of 450 R at 50 R/min and returned to ordinary cages. A plot of the weights of the animals 28 days later versus the difference between the actual and theoretical oxygen consumption (ΔO_2) showed that the weight increase was smaller in those animals that showed the greatest deviation of actual from theoretical values. In extreme cases, the animals died. The absolute weights and the respiratory coefficients showed no correlation with ΔO_2 or with the weight increase. Blood samples taken regularly from some of the animals showed no significant changes from normal. Animals whose blood was not sampled were in better condition than those used for blood tests. They showed a negative oxygen consumption in comparison with the positive values for the sampled group and a correlation between ΔO_2 and the absolute weight. As the experiments progressed, the individual differences disappeared because of the takeover of the recovery processes. The results therefore show that individual radiation sensitivity of animals may be differentiated by the ΔO_2 values of the animals. (TTT)

33366 DEVELOPMENT OF A CONDITIONED REFLEX TO IONIZING RADIATION IN FISH AND RABBITS. A. B. Tsypin and Yu. A. Kholodov. Radiobiologiya, 4: 402-8 (1964). (In Russian)

Experiments were made on eleven carp and ten rabbits. Electric stimuli were applied through electrodes connected to a battery through an induction coil; irradiation was from a ^{60}Co gamma source at 0.5 to 0.1 R/sec for 5 to 10 sec. Irradiation of the fish before the development of the conditioned reflex caused no motor reaction. However, after four to thirteen combined irradiations and electric stimuli, most of the fish began to move when irradiated only. Although the results show that a conditioned reflex to irradiation may be developed in fish, it is not so strong a reflex as that to sources of sound or light. It is somewhat similar to the reflex to a magnetic field in that the induction period is longer than that of sound and light. The reflex was developed similarly in fish that were blinded or deprived of the organ of hearing. Removal of the forebrain, and especially damage to the midbrain, interfered with the development of the reflex. The reactions of normal rabbits only are discussed, but they also developed a conditioned reflex to radiation under similar stimulations. Kymographs of the rabbit and fish reactions and photographs of the normal and operated fish brains are shown along with tabulated data. (TTT)

33367 FUNCTIONAL STATE OF THE ADRENALS AFTER IRRADIATION. E. A. Prokudina (Central Scientific Research Inst. of Medical Radiobiology, Leningrad). Radiobiologiya, 4: 409-13(1964). (In Russian)

Female white mice weighing 18 to 20 g were gamma-irradiated (^{60}Co) to 800 R in four doses of 200 R each at 1-week intervals (22.8 R/min), which is a dose known to cause 30 to 50% deaths in 1 month. The leucocyte count of the peripheral blood was determined, along with the adrenal weights and their cholesterin and ascorbic acid contents as indications of their functional state. Measurements were made at times from 1 to 12 months after irradiation. Neither the leukocyte count in 9 months nor the adrenal weights in 12 months differed significantly from control values at any time. However, the ascorbic acid content was 13 to 15% lower at 1, 3, 6, and 9 months, and the cholesterin content was low at 1, 6, and 12 months, high at 3 months, and equal to that of the controls at 9 months. The data indicate that there are two opposing and parallel reactions. The reaction to exogenous ACTH was practically the same in the irradiated and control animals. Considering that the ascorbic acid change might be general rather than local, the livers of some mice were examined for ascorbic acid, but no difference from the control values was found. (TTT)

33368 THE STATE OF THE CENTRAL M-CHOLINE REACTIVE SYSTEMS OF ^{60}Co-IRRADIATED MICE. V. G. Ovakimov, S. P. Yarmonenko, and V. I. Ivanov (Inst. for Industrial Hygiene and Preventive Medicine, Moscow). Radiobiologiya, 4: 414-18(1964). (In Russian)

White mice weighing 18 to 22 g were whole-body gamma-irradiated (^{60}Co) in a single dose to 3000 R at a rate of 250 R/min. Before and at different times after irradiation the minimum dose of atropine to suppress the arecoline effect was determined. Injection of 5 mg of atropine per kilogram before irradiation completely blocked the effect of arecoline in all animals studied. The experiments were continued for 48 hr. The data obtained showed that for a dose of 1000 R the excitability of the central M-choline reactive system did not change immediately after the irradiation, but increased at 24-48 hr. With a dose of 3000 R, the excitability increased during the first 4 hr. However, 40 days after irradiation to 600 R, the excitability decreased. These data are in agreement with work published elsewhere suggesting that there is a relation between the mechanism of the initial physiological effects in the central nervous system, which appear after irradiation, and changes in the conditions of synaptic transmission. (TTT)

33369 EFFECT OF PRELIMINARY INTRODUCTION OF DYSENTERY AND STAPHYLOCOCCUS BACTERIA ON THE IMMUNITY OF IRRADIATED ANIMALS TO TYPHOID BACTERIA. A. P. Duplishcheva and O. V. Chakhava (Gmelin Inst. of Epidemiology and Microbiology, Moscow). Radiobiologiya, 4: 419-23(1964). (In Russian)

Rabbits weighing 2.5 to 3.0 kg were x-irradiated to 400 and 600 R, and white mice weighing 14 to 16 g were γ-irradiated (^{60}Co) to the same doses. For injection to the rabbits, formalinized bacteria and yeast autolysates prepared from washed (with physiological saline) and centrifuged cultures were used. Live cultures of typhoid bacteria were used for the mice. A single intravenous injection of dysentery bacteria on one and seven days before irradiation showed a protective action in the formation of antigens to typhoid bacteria in the rabbits that had been immunized with typhoid bacteria 1 day before irradiation. Similar injections of yeast autolysates in rabbits also showed protective action in the formation of such antigens. Injection of dysentery and staphylococcus bacteria to mice 1 day before irradiation did not contribute to the development of a high-level innoculation immunity, but it did significantly increase the resistance of the irradiated animals to infectious living cultures of typhoid bacteria. Practically, the susceptibility of these animals was similar to that of nonirradiated and nonimmunized. The mechanism of the protective action of bacterial products administered before irradiation is still not clear and needs further study. (TTT)

33370 CHANGES IN THE SENSITIVITY OF IRRADIATED MICE TOWARD THE ENDOTOXINS OF INTESTINAL AND TYPHOID-FEVER BACILLI. Yu. S. Barenko (Gorkii Medical Inst., Don, USSR). Radiobiologiya, 4: 424-5(1964). (In Russian)

The sensitivity of irradiated white mice toward the endotoxin of intestinal and typhoid-fever bacilli was examined. The endotoxins were administered to irradiated and healthy mice, determining the sensitivity from the survival rate. A dose of 500 R was chosen for these tests because it has been found that exposure to 600 R kills 100% of the animals while 400 R does not effect the sensitivity toward the intestinal bacilli. The endotoxins were administered 2 hours before and 3, 6, 12, and 26 days after irradiation. It was found that introduction of the typhoid fever endotoxin 2 hours before irradiation increases the mortality rate, as compared with unirradiated and irradiated but not treated animals. A similar observation was made on irradiated animals treated with the Coli endotoxin on the 3rd, 6th, and 26th day and with the typhoid fever endotoxin 3 to 12 days after the irradiation. Thus, the sensitivity of irradiated mice toward these endotoxins is increased, and the natural antitoxic immunity is markedly lowered. (TTT)

33371 CHANGES IN THE NATURE OF THE RADIATION-INDUCED MUTATIONS IN THE SPERMATIDS OF THE DROSOPHILA UNDER THE INFLUENCE OF ARGININE. E. A. Abeleva (Inst. of Biological Physics, Academy of Sciences, USSR). Radiobiologiya, 4: 426-31(1964). (In Russian)

The spermatids of Drosophila, mice, and certain other animals exhibit marked radiation sensitivity at medium (1000 to 1200 R) doses while high doses are relatively less effective. Mutations after exposure of spermatids to 4000 R have not been studied. As factors which slow the metabolism reduce the mutation frequency, the effect of such agents was investigated; chloramphenicol reduces the frequency of mutations in spermatids and increases it in spermias, evening out the genetic radiation sensitivity. An agent counteracting the effect of chloramphenicol — arginine — was investigated. Arginine is not synthetized by the animals and is needed for the synthesis of the protamines. Male flies treated with arginine and control flies were exposed to 1000 R of γ radiation. The frequency distribution of the appearance of sex-linked recessive lethal mutations in the gametas of irradiated specimens revealed some differences between the arginine-treated and untreated cases only in the area corresponding to the irradiated spermatids, or the phase of the nucleo protamine synthesis. The genetic sensitivity of males treated with arginine during the period of highest sensitivity — the 5th and 6th days — was reduced almost to the level of the spermias; the decrease of the sensitivity of the spermias started several days earlier and the period of increased sensitivity was shortened. The data agree well with the theory postulating the biochemical nature of the origin of the mutations in the spermatids. (TTT)

33372 THE EFFECT OF LOCAL IRRADIATION OF THE CHROMOSOMES OF A DIVIDING CELL ON THE FORMATION OF THE CELL MEMBRANE. A. D. Gruzdev (Inst. of Cytology and Genetics, Novosibirsk, USSR). Radiobiologiya, 4: 432-4(1964). (In Russian)

It is widely assumed that at the time of cell division, the nucleus is metabolically inactive. This question was further investigated, following up a previous study concerning the effect of the nucleus on the formation of the cell membrane. Dividing cells of the staminal fibers of Tradescantia virginica in a drop of water, with some glucose added, were studied, protecting the preparation with paraffin oil from drying, and irradiating a small portion of the anaphasic chromosomes. The exposure caused a change in the time period required for the formation of the cell membrane; this time t was defined as the period ranging from the end of the anaphase to the formation of the cell membrane. The measurements included the determination of the relation between t and the amount of the energy absorbed by the cell during the anaphase. It was found that small doses exert a stimulating effect; the membrane formation was accelerated and was accompanied by morphological changes. The nucleus may reach the stage of late telephase but only cytoplasms with small amount of granules were noted. The change in t is probably due to injury in the chromosome structure. Exposure of chromosomes to ultraviolet light resulted in a decrease of the sensitivity from the beginning to the end of the anaphase. It was concluded that the chromosomes of dividing cells control some of the processes of cell membrane formation. (TTT)

33373 DISTRIBUTION OF CARBON-14 LABELED β-MERCAPTOPROPYLAMINE IN THE TISSUE AND ITS ELIMINATION FROM THE ORGANISM. G. V. Kalistratov (Inst. of Biophysics, Moscow). Radiobiologiya, 4: 440-3 (1964). (In Russian)

β-Mercaptopropylamine (MPA) is one of the best available chemical protective agents against the effects of ionizing radiation at the lethal and sublethal levels, but the mechanism involved in its action is not yet clarified. The problem of the absorption and distribution of this compound in the tissue and its excretion from the organism was investigated by using a compound labeled with ^{14}C at the second C position. The preparation was administered intraperitoneally to male white mice at a dose of 300 mg/kg, corresponding to about 340,000 pulses/minute per animal. The mice were killed 10 and 20 minutes and 1, 6, and 24 hours after the treatment. In a second series of tests the animals were irradiated within 10 minutes after administering the MPA at a total dose of 812 R of x radiation. The analysis revealed that within 10 minutes all the examined organs and tissues contained the labeled MPA; the largest amounts were found in the kidneys, spleen, lungs, and liver. As the result of the irradiation, the MPA concentration was reduced in all the organs and tissues, being excreted by both the urine and the feces but to a greater extent by the feces. The results agree well with data reported by other authors who worked with ^{35}S-labeled MPA. The high ^{14}C–MPA concentration in the lungs cannot be explained satisfactorily; its presence in the kidney and the intestines is due to the excretion function. (TTT)

33374 FORMATION OF WINTER WHEAT MUTANTS UNDER THE INFLUENCE OF FAST NEUTRONS. Chenman Hsu (Inst. of Biophysics, Moscow). Radiobiologiya, 4: 444-50(1964). (In Russian)

Previous work in Sweden indicated that neutron radiation is 10 to 100 times more effective on barley than x radiation. P. K. Shkvarnikov et al. (Radiobiologiya 1: 296(1961)) compared the mutagenic effect of thermal-neutron, γ, and x irradiation on summer wheat and found that exposure of the grains to any of these radiations results in a 50- to 100-fold increase of the mutant frequency, as compared with spontaneous mutants. This study was continued by comparing the mutagenic action of γ radiation, fast neutrons, and ethylenimine on a hybrid winter wheat. Air-dried grains were exposed at the IRT-1000 reactor to doses of 350 rad, consisting of 210 rad of fast neutrons and 140 rad of γ radiation, 705 rad (425 fast neutrons + 280 γ), 1410 rad (850 fast neutrons + 560 γ), and 1760 rad (1060 + 700 γ). Immediately after the irradiation the grains were planted in soil of average fertility. It was found that the frequency of the mutations increases with the increased fast-neutron

dose. The largest number of agriculturally favorable mutations were obtained at 705 rad. Comparison of the mutagenic effects indicated that the fast neutrons are about 47 times more effective than γ radiation, on the basis of the same number of mutations. The largest variety of mutations was obtained by the action of ethylenimine, the lowest variety was due to the action of fast neutrons. (TTT)

33375 CYTOGENETIC ANALYSIS OF THE COMBINED ACTION OF CHEMICAL MUTAGENS AND IRRADIATION ON BARLEY SEEDS. S. A. Valeva (Inst. of Biological Physics, Moscow). Radiobiologiya, 4: 451-6(1964). (In Russian)

The joint action of chemical and physical mutagens has been examined by determining the effect of γ radiation alone, γ radiation preceded by a treatment with colchicine and ethylenimine, and ethylenimine alone on barley seeds. In joint-action studies the seeds were treated with a solution of 0.02% ethylenimine and 0.1% colchicine in distilled water for 24 hours, exposing them subsequently to 1000 R of γ radiation. Cytologic analysis of the seeds revealed that the smallest number of chlorophyl mutations is obtained by treatment with γ radiation alone, in spite of the resulting chromosome aberrations and the high sterility of the plants. Preliminary treatment with ethylenimine reduced the number of chromosome aberrations and increased the number of chlorophyl mutations, the number of which may be increased by using lower radiation doses. The mutation spectrum caused by the joint action differed from the spectrum due to the separate action of the two factors. Ethylenimine yielded the largest number of chlorophyl mutations. Thus, it may be concluded that the radiation causes the chromosome aberrations and ethylenimine is responsible for the gene mutations; the preliminary treatment with colchicine increases the radiation-induced injury. No positive correlation could be found between the number of the chlorophyl mutations, the percentage of chromosome rebuilding in the first mitoses of the meristem, and the sterility of the plants. (TTT)

33376 RESULTS OF STUDIES CONCERNING THE REMOVAL OF NEWLY GATHERED POTATO TUBERS FOR THE DORMANT STAGE. Ts. M. Avakyan, S. P. Semerdzhyan, and R. R. Atayan (Armenian Agricultural Scientific Research Inst., Echmiadzin, USSR). Radiobiologiya, 4: 463-4(1964). (In Russian)

The soil and the climatic conditions of the Ararat Lowlands in Armenia, where the experiments were carried out, make it possible to have two potato harvests per year. This presents problems for providing seed materials for the summer planting because the newly gathered spring harvest yields dormant material. Experiments were therefore carried out to obtain seed material by exposing the newly gathered tubers to ionizing radiation, thus removing them from the dormant stage. The specimens tested were exposed to x radiation at total doses of 50, 300, and 1000 R, studying also the aftereffects of the irradiation. The tubers were allowed to germinate in quartz sand at 24 ± 2°C. It was found that the irradiated tubers yielded a markedly larger crop than the untreated ones. It is concluded that treatment with x radiation represents a practical method for obtaining seed material for the summer planting season. The larger doses had such a strong effect on the ontogenetic development cycle that the dormant stage was markedly shortened. (TTT)

33377 THE RECOVERY RATE OF THE ORGANISM AFTER IRRADIATION AT VARIOUS DOSES. I. G. Akoev. Radiobiologiya, 4: 467-8(1964). (In Russian)

The speed of recovery after irradiation is an indication of the resistance of the organism to repeated exposures. This problem was studied on 5000 white mice, mostly 2 to 4-month old males, irradiated with a ^{60}Co source at 35 R/min. The first exposure, ranging from 50 to 600 R, was repeated within 1 to 15 days. The recovery rate was estimated on the basis of the rate of decrease of the residual radiation injury period, calculated from the $LD_{50/30}$ values after the first and second exposures. It was found that the decrease of the period of the residual injury as a function of time follows an exponential law; the half-recovery time depends on the radiation dose. The recovery rate of mice was found to be highest after an exposure of 400 R. At higher doses, this value is sharply reduced; this is probably due to an increase of the seriousness of the injury. Reduction of the dose to a level below 400 R resulted in a gradual decrease of the recovery rate, probably because of the lowered strength of the agent, resulting in a lesser mobilization of the compensating reparative mechanism which controls the rate of the recovery from repeated exposures. (TTT)

33378 APPEARANCE OF BREAKS IN THE X CHROMOSOME UNDER THE INFLUENCE OF IONIZING RADIATION DURING THE SPERMATOGENESIS OF DROSOPHILA MELANOGASTER. E. A. Abeleva and N. A. Potekhina. Radiobiologiya, 4: 468-9(1964). (In Russian)

One to two days old Drosophila melanogaster inbred males were exposed to 1000 R of x radiation at 376 R/min. The irradiated flies were mated with wild males possessing fracture in the X chromosomes, controlling 4 recessive genes; the X chromosome of the male possesses the normal (dominant) allelomorphs of these genes. The effect of the radiation on the surviving offspring was examined. It was found that the appearance of deletions in the spermatids was 6 times larger than in the spermias. In order to study the effect of arginine on the frequency of the mutations of the irradiated males, the treated flies were exposed to 1000 R of γ radiation from a ^{60}Co source. No direct effect attributable to the arginine could be detected, but no definite conclusions can be reached from these experiments. The frequency of the deletions reached its maximum on the 8th day after the irradiation, indicating that the increase of the deletion frequency occurs in the diploid cells. (TTT)

33379 DEMONSTRATION OF AN ANOXIC COMPONENT IN A MOUSE TUMOR-CELL POPULATION BY IN VIVO ASSAY OF SURVIVAL FOLLOWING IRRADIATION. W. E. Powers and L. J. Tolmach (Washington Univ., St. Louis). Radiology, 83: 328-36(Apr. 1964).

The sensitivity of cells of the 6C3HED mouse lymphosarcoma to 220-kv x rays was measured under a variety of conditions designed to alter the oxygen tension to which the cells were subjected. Irradiation in vivo in C2H mice yielded a survival curve with two components corresponding to a cell population that is 99 per cent sensitive (D_0, 110 rad) and 1 per cent resistant (D_0, 260 rad). Radiation resistance did not appear to be heritable. Irradiation in vitro demonstrated only the sensitive component. Irradiation in situ in dead (presumably anoxic) mice gave survival data that indicate at least a twentyfold increase in the resistant population. Irradiation in mice under hyperbaric oxygen yielded a survival curve which indicates that the resistant fraction has been reduced to 0.1 per cent. It is concluded that when growing subcutaneously in the flank of the mouse, the tumor-cell population is heterogeneous with respect to degree of oxygenation. (auth)

33380 CHANGES PRODUCED IN RAT LIVER BY A SINGLE PARTIAL IRRADIATION OF THE ORGAN. I. IN THE COURSE OF THE FIRST THREE MONTHS. A. Lacassagne and Lucienne Hurst (Fondation Curie, Paris). Rev. Franc. Etudes Clin. Biol., 8: 20-4(Jan. 1963). (In French)

A systematic study was made of the modifications brought about by a single x-ray dose of 4000 R on the left and median liver lobes of rats fed a complete diet, and a comparison was made with protected liver tissue in the same animals. The left and median lobes were surgically exteriorized, irradiated, with protection of the rest of liver, and replaced. Animals were sacrificed one hour to 77 days following the operation. Macroscopic changes consisted in atrophy of the irradiated lobes, with compensatory hypertrophy of the protected lobes. An inflammatory reaction was, present on the surface of the irradiated lobes, became covered by a white fibrinous film that made these lobes adhere to each other. Cytologic and histologic changes throughout the postirradiation period are described. (TCO)

33381 CHANGES IN SERUM PROTEINS, PROTEIN FRACTIONS, NONPROTEIN AND AMINO NITROGEN IN COMBINED RADIATION AND BURN INJURY. I. T. Abasov. Sb. Nauch. Rabot Nauchn.-Issled. Rentgeno-Radiol. Inst. Azerb. SSR, 245-9(1962).

The effect of single doses of irradiation (500 and 300 R), burn to the hind legs of albino rats by immersion into 90° water up to the crest of the iliac bone or up to the mid-thigh, and a combination of these traumas upon protein (I) content, protein fractions, nonprotein, and amino nitrogen in the serum was determined 3, 20, and 40 days after trauma was sustained. Irradiation with 300 did not alter the indexes studied; 3 days after combined trauma there was a reduction in the (I) and albumin (II) content and albumin-globulin coefficient and gamma globulin with a simultaneous appreciable increase in alpha- and beta-globulin; burn and combined trauma were also accompanied by increased nonprotein amino nitrogen content. After 20 days all the changed indexes returned to normal except for the (II) concentration, which returned to normal after 40 days. (Referativnyy Zhurnal, Biologicheskaya Khimiya, No. 20, 1963)

33382 INTENSITY AND RELATIONSHIP BETWEEN NUCLEIC ACID, PROTEIN AND LIPID SYNTHESIS IN THE SPLEEN OF IRRADIATED RATS. A. I. Nikolaev and A. Kh. Akhmadieva. Sb. Nauchn. Tr. Nauchn. Issled. Inst. Rentgenol., Radiol. i Onkol., Uz. SSR, 2-3: 343-5(1962).

Rats receiving 600 roentgens of gamma radiation were given subcutaneous injections of ^{14}C-glycine in the thigh, and four hours later, nucleic acid (NA), protein (P), and lipid (L) radioactivity of the spleen and serum P were determined. One hour after irradiation, ^{14}C-glycine uptake in these fractions showed almost no difference from that of the controls. Five days after irradiation, synthesis of NA and P of the spleen and serum, as determined by ^{14}C-glycine uptake, was considerably inhibited by 41, 28, and 20%, respectively, while L synthesis was 16% higher. On the fifteenth day after irradiation, NA synthesis of the spleen and P synthesis of serum was reduced by 27 and 9%, while splenic P and L was 10 and 30% higher. On the twentieth post-irradiation day (period of recovery), splenic NA synthesis was almost normal: 83% of the control level. Splenic and serum P synthesis was considerably higher, by 23 and 45%, while splenic L synthesis was 28% lower. Depending on the stage of radiation sickness against a background of reduced ^{14}C-glycine uptake by splenic NA, there were both inhibition and increased uptake in splenic and serum P; ^{14}C-glycine uptake in splenic L was higher during the stage of development of radiation sickness and lower during the recovery period. (Referativnyy Zhurnal, Biologicheskaya Khimiya, No. 20, 1963)

33383 POLYPLOIDY INDUCED BY X-RAYS IN CHINESE HAMSTER CELLS IN VITRO. C. K. Yu and W. K. Sinclair (Argonne National Lab., Ill.). Science, 145: 508-10(July 31, 1964).

The incidence of polyploidy (specifically, in this case, the doubling of the stemline chromosome number) induced by x rays in cells cultured in vitro is about the same for both near-diploid and near-tetraploid sublines of the Chinese hamster. Endoreduplication is a principal cytological mechanism for this form of induced polyploidy. (auth)

33384 SEED RADIOSENSITIVITY: A NEW CONSTANT. Thomas S. Osborne and Allyn O. Lunden (UT-AEC Agricultural Experiment Station, Oak Ridge, Tenn.). Science, 145: 710-11(Aug. 14, 1964).

A constant was derived by which seed radiosensitivity can be predicted from nuclear volume of certain embryonic cells. From nuclear volumes alone, predictions of radiation response for two unknown species were made; experimental values in both cases fell below the 95% but within the 99% confidence intervals of the predictions. (P.C.H.)

33385 THE EFFECTS OF X-IRRADIATION ON THE BIOLOGICAL ACTIVITY OF COTTONMOUTH MOCCASIN (ANCISTRODON PISCIVORUS) VENOM. Herschel H. Flowers (Army Medical Research Lab., Fort Knox, Ky.). Toxicon, 1: 131-6(1963).

Agkistrodon piscivorus venom in a dilution of 1 mg venom per 10 ml distilled water was exposed to 18375 rad ± 263 rad of x irradiation to determine the effect on its local reactivity and lethality. The precipitation patterns of antigens by immunodiffusion and immunoelectrophoresis of crude and irradiated venom was compared. The results indicate that the local reactivity of the venom was reduced 50 to 65 per cent. The lethal effect was markedly decreased. It took almost six times the weight of lyophilized x irradiated venom to produce the mouse LD_{50}. Immunoelectrophoresis and immunodiffusion demonstrated little difference in the pattern of antigens of x irradiated and normal venom. (auth)

33386 THE RATE OF SKIN AUTOGRAFTS AND HOMOGRAFTS IN SUBLETHALLY IRRADIATED RATS. V. Silobrcic, S. Keckes, and N. Allegretti (Institut "Rudjer Bošković," Zagreb). Transplantation, 2: 459-63(July 1964).

Skin autografts transplanted to sublethally irradiated rats (500 and 600 r) showed post-irradiation hemorrhagic changes resulting in necrosis and partial destruction. By delaying the grafting procedure for several days after irradiation both the incidence and the intensity of post-irradiation damage was diminished. Homografts in sublethally irradiated hosts showed changes similar to those observed in autografts. Prolongation of survival time was found to be limited. The role of post-irradiation injuries in the process of graft breakdown in irradiated animals is discussed. (auth)

33387 PERSISTENCE OF TOLERANCE TOWARDS DONOR-TYPE ANTIGENS AFTER TEMPORARY CHIMERISM IN RATS. H. Balner (Toegespast Naguurwetenschappelijk Onderzoek, Rijswijk, Netherlands). Transplantation, 2: 464-74(July 1964).

Temporary takes of homologous bone marrow were obtained in a number of sublethally irradiated rats. The ani-

mals were tested for specific tolerance toward donor-type antigens by skin grafting at various intervals after irradiation. About 50% of the animals in which reversion to host-type hemopoiesis had been proven by serological typing of erythrocytes and peritoneal nucleated cells, rejected donor-type skin. The remaining animals, however, did not regain host-type immune reactivity after reverting, but remained totally or partially tolerant toward donor-type antigens. This reduced reactivity seemed specific and permanent, suggesting the possibility of tolerance toward transplantation antigens across strong histocompatibility barriers, independent of a chimeric state. (auth)

33388 ADOPTIVE TRANSFER OF SENSITIVITY TO ALLOGENEIC VERSUS XENOGENEIC SKIN GRAFTS IN MICE. Marvin L. Tyan and Leonard J. Cole (Naval Radiological Defense Lab., San Francisco). Transplantation, 2: 515-21(July 1964).

Graded numbers of syngeneic spleen and lymph node cells from nonsensitized or sensitized donors were transferred to groups of sublethally irradiated mice (670 rad) which were then grafted with allogeneic and xenogeneic skin. The donor mice had been sensitized with allogeneic or xenogeneic skin grafts, allogeneic and xenogeneic grafts, or cell suspensions of allogeneic or xenogeneic spleen cells. The results indicated that lymphoid cells from donors sensitized by means of skin grafts elicited rejection of appropriate skin grafts significantly sooner than did nonsensitized cells or cells from donors sensitized with dissociated spleen; lymphoid cells from donors sensitized with allogeneic spleen cells appeared to be nonsensitized with respect to transferring skin graft immunity; in addition they appeared to be inhibited by the presence of a serum factor, perhaps specific antiserum; lymphoid cells from donors sensitized with xenogeneic spleen cells did not bring about rejection of xenogeneic grafts significantly sooner than did nonsensitized cells; and first and second-set responses to allogeneic grafts, temporally comparable to those seen in normal mice, could be adoptively transferred, which was not possible with respect to xenogeneic grafts. (auth)

33389 RADIOSENSITIVITY OF TROPICAL PLANT SPECIES: CARICA PAPAYA, MANIHOT DULCIS, AND SWIETENIA HUMILIS. Carl C. Moh (Instituto Interamericano de Ciencias Agricolas, Turrialba, Costa Rica). Turrialba, 13: 180-1(July-Sept. 1963). (In Spanish)

At a dose of 12 Kr of acute gamma radiation, the percentage of survival of papaya (Carica papaya) seeds was not appreciably different from the control. Further experimentation showed that the LD_{50} for papaya seeds was in the vicinity of 19 Kr. Three-month-old papaya plants could not survive at a chronic dose of higher than 600 r/day for three months. A chronic dose of 300 r/day was also lethal to the plants but required an irradiating period of more than three months. Nodes of cassava (Manihot dulcis) were rather sensitive to acute gamma radiation; the projected LD_{50} lay in the vicinity of 3 Kr. Preliminary tests with four-month-old mahogany (Swietenia humilis) plants showed that mahogany was relatively resistant to chronic radiation. (auth)

33390 THE ROLE OF OLEIC ACID OXIDATION PRODUCTS IN THE PRIMARY PROCESSES OF CELLULAR RADIATION INJURY. G. I. Gasanov. Vopr. Fiziol., Akad. Nauk Azerb. SSR, Sektor Fiziol., 6: 135-43(1963).

On cultures of Lygosaccharomyces Bailli yeast a study was made on the role of intermediate products of oleic acid oxidation (POO) in the primary processes of radiation injury as well as of the effect of O_2 on the radiomimetic action of POO. It was found that cell damage with POO depends on the degree of oxidation, the toxic effect being related to peroxides and not epoxides. In the absence of O_2 the toxic effect of peroxides is reduced. The produced oxygen effect (OE) is similar to the OE with irradiation. It is considered that irradiation produces two consecutive reactions related with the presence of O_2 in the medium: production of peroxides and interaction between the latter and the biosubstratum. (Referativnyy Zhurnal, Biologicheskaya Khimiya, No. 24: 1963)

33391 STUDIES OF ADOLESCENTS EXPOSED IN UTERO TO THE ATOMIC BOMB, NAGASAKI, JAPAN. I. GENERAL ASPECTS: CLINICAL AND LABORATORY DATA. Gerard N. Burro, Howard B. Hamilton, Zdenek Hrubec, Kichiro Amamoto, Fumiko Matsunaga, and A. Bertrand Brill (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). Yale J. Biol. Med., 36: 430-44 (June 1964).

An intensive two-year study of 286 Nagasaki adolescents, ages 13 to 14, was conducted as part of a long-term program to determine possible differences in growth and development which might be attributed to in utero exposure to the atomic bomb. Three comparison groups were studied: group I, whose mothers were within 2,000 meters of the hypocenter; group II, whose mothers were located between 3,000 to 4,999 meters from the hypocenter; and group III, whose mothers were not in the city at the time of the bomb. A significantly higher frequency of mental retardation and minor congenital malformations was found in group I males, but not in the females. Although group I females who were in the first trimester of gestation at the time of the bomb and whose mothers experienced the acute radiation syndrome had poorer visual acuity than comparable children of asymptomatic mothers, the small number of observations requires caution in interpretation of this finding. Parasitic infestation occurred in about one-third of the subjects, and group I had significantly greater infestation than did the other comparison groups. Trichocephalus and Ascaris infestation accounted for the higher prevalence. Hookworm occurred less frequently. It is suggested that these findings are probably associated with different dietary and living habits. No cases of leukemia or malignancy were found, but the sample was not large enough to detect even a tenfold increase in incidence. No consistent significant differences attributable to a radiation effect were noted among the comparison groups in regard to radial pulse, blood pressure, hematologic, or urine examinations. (auth)

33392 PHOTOREACTIVATION OF UV-INACTIVATED POLYURIDYLIC ACID. Adolf Wacker, Makoto Ishimoto, Prakash Chandra, and Reinhold Selzer (Universität, Frankfurt am Main). Z. Naturforsch., 19b: 406-8(May 1964). (In German)

A study on the effect of uv-irradiated polyuridylic acid on the incorporation of phenylalanine into the polypeptide precipitable through trichloroacetic acid, in a cell-free system from E. coli was made. Attempts were made to reactivate the uv-inactivated polyuridylic acid through hydrogen peroxide, uranyl acetate, and visible light. It was found that polyuridylic acid irradiated at a dose of 1.2×10^5 ergs/mm^2 could be completely reactivated, while the one irradiated at a higher dose of 2.4×10^5 ergs/mm^2 could not be completely reactivated under the conditions used. The chemical effects of hydrogen peroxide and uranyl acetate on uv-irradiated polyuridylic acid were also studied. The results show that the photoreactivating effect of uranyl acetate and hydrogen peroxide is due to their ability

to split the uracil dimers formed during uv irradiation. (auth)

33393 THE EFFECT OF GAMMA IRRADIATION AND WARMING ON VARIOUS STRAINS OF SACCHAROMYCES CEREVISIAE. H. Gaisch, K. Prosenz, and D. Steinlechner (Reaktorzentrums, Seibersdorf, Austria). Z. Naturforsch., 19b: 430-3(May 1964). (In German)

The principal distinction in the effects of gamma radiation and heating on yeast can not be found by comparison of the dose survival curve. With yeast there is the simple possibility of determining directly the cell count by fermentation measurements so that the time pattern of the growth of a culture can be followed. In the distinction of heating effects, irradiation does not kill a cell immediately. The irradiated cells still have the capacity to carry out some germinations before the division mechanism fails. (tr-auth)

33394 THE PLOIDY DEGREE DEPENDENCE OF RADIO-INDUCED MUTATION RATES IN A SYSTEM OF EXTENSIVELY HOMOZYGOTE AND ISOGENIC SACCHAROMYCES STRAINS. Klaus Haefner (Freie Universität, Berlin). Z. Naturforsch., 19b: 451-3(May 1964). (In German)

An extensively homozogote and isogenic system of Saccharomyces strains with ploidy classes p = 1 to 4 was used for the study of the ploidy degree dependence of radio-induced mutation rates. All strains required isoleucine and valine (IV), and the functional back-mutation to the IV- nonneed was investigated. Both x-ray and uv irradiations were made. The results are tabulated. The mutation rates for the two types of radiation are different. After uv irradiation there is a conspicuously low effective mutability of the triploid and tetraploid strains. It was concluded that no valid explanation can be given of the results. (J.S.R.)

33395 VLIYANIE IONIZIRUYUSHCHEI RADIATSII NA POLOVYE ZHELEZY, BEREMENNOST', I VNUTRIUTROBNYI PLOD. (Effects of Ionizing Radiation on Ovaries, Pregnancy, and the Fetus). V. I. Bodyashina, A. P. Kiryushchenkov, M. N. Pobedinskii, and N. M. Pobedinskii. Moscow, Medgiz, 1962. 184p.

Radiation effects on the sex glands and fertility in humans were studied, and the outcome of pregnancy in women exposed to radiation was investigated. A special study was made of radiation sickness pathology during pregnancy and the effects of radiation on the embryo, fetus, ovaries, and placenta. Data are given on chemical protection of the mother and fetus. Problems of prophylaxis and therapy of disturbances in menstrual and child bearing functions in personnel handling radioactive materials are discussed, as well as prophylaxis of radiation injuries during x-ray diagnostics and therapy. (R.V.J.)

33396 THE PATHOLOGY OF IONIZING RADIATION. Shields Warren. A Monograph in the Carl Vernon Weller Lecture Series. Springfield, Illinois, Charles C. Thomas, Publisher, 1961. 50p. $3.00.

Somatic effects of ionizing radiation on mammals are discussed. Based on clinical and experimental evidence, on review of accidental and occupational human exposure, and on study of survivors of the Hiroshima and Nagasaki bombs, acute and chronic syndromes are presented for various dose ranges. Gastrointestinal, hematological, and late effects such as cancer and leukemia are described in detail. When hazards are weighed against benefits, it is concluded that ionizing radiation should not be rejected on the premise of guarding against possible ills. (H.M.G.)

33397 BIOLOGICAL EFFECTS OF IONIZING RADIATIONS. Arthur C. Upton (Oak Ridge National Lab., Tenn.). p.199-240 of "International Review of Experimental Pathology. Vol. 2." New York, Academic Press, 1963.

Aspects of the biological effects of ionizing radiations relevant to experimental pathology are surveyed. Topics discussed include: effects on the cell, inherited effects, effects on the animal, acute radiation syndrome, delayed somatic effects, factors modifying the radiation response, and internally deposited radionuclides. (H.M.G.)

33398 THE EFFECT OF RADIOACTIVE RADIATION ON THE AMINO ACID CONTENT OF WHEAT SPROUTS. L. P. Vitkalenko. p.359-60 of "Fiziol-Biokhimicheskii Osnovi Pidvishchennya Produktivnosti Roslin." Kiev, Derzhdil'gospbidav Ukrainian SSR, 1963.

The free amino acid content was determined in wheat sprouts irradiated by a dose of 10000 R under conditions of the addition of physiologically active substances. Results of the analysis of the following groups of sprouts were compared: control; irradiated (I) by 10000 R; (I) plus $MnSO_4$ (0.001%); (I) plus thiamine; (I) plus niacin; (I) plus riboflavin; (I) plus gibberellin; $MnSO_4$. There was a decrease in some amino acids in the irradiated sprouts. The addition of active substances together with $MnSO_4$ after irradiation increased the amino acid level to that of the control group. (Referativnyy Zhurnal, Biologicheskaya Khimiya, No. 23, 1963)

33399 FLUORESCENCE MICROSCOPY OBSERVATIONS ON BONE MARROW UNDER RADIATION THERAPY. B. Chonè (Universität, Heidelberg). p.207-11 of "Proceedings of the 9th Congress of the European Society of Haematology, Lisbon, Portugal, Aug. 26-31, 1963. Volume I." Basel, Verlag S. Karger AG, 1963.

Fluorescen microscopy using fluorochrome acridine orange was used to examine the bone marrow from cancer patients that had been exposed to local therapeutic doses of x or γ radiation delivered to the chest or abdominal region. Morphological changes in bone marrow during the course of fractionated radiation exposure were demonstrated by this vital staining technique. Visible effects of fluorescence microscopy observed in bone marrow from irradiated rats were not observed in the human bone marrow cells. (C.H.)

33400 INFLUENCE OF IONIZING RADIATION ON THE BIOSYNTHESIS OF HEME. A. M. Dancewicz, Guni Gutniak, Anna Mazanowska, Teresa Maiinowska, and E. Kowalski. p.631-6 of "Proceedings of the 9th Congress of the European Society of Haematology, Lisbon, Portugal, Aug. 26-31, 1963. Volume I." Basel, Verlag S. Karger AG, 1963.

The effects of doses of 600 to 800 R x radiation on hemoglobin synthesis in rabbits was studied by measurements of the rate of incorporation of ^{14}C-labeled precursors into heme, assays of the activity of enzymes involved in heme synthesis, and determinations of some free precursors of heme in organs of irradiated animals. Results showed that heme was synthesized in spite of greatly diminished activity of some of the enzymes. Possible reaction mechanisms are postulated. It was concluded that the enzymatic chain reactions used in the synthesis of heme can be employed as a model system for studies on basic problems in molecular radiobiology. (C.H.)

33401 BIOLOGICAL EFFECTS OF RADIATION. Donald R. Chadwick (Public Health Service, [Washington, D. C.]) and Simon P. Abrahams. 16p. (CONF-623-2)

From American Medical Association Congress on Environmental Health Problems, Chicago, May 1964.

Difficulties encountered in evaluating the effects of radiation on man are reviewed. It is pointed out that our knowledge of the biological effects of radiation has many gaps, but enough is known that practitioners of medicine, dentistry, and public health should make every feasible effort to prevent or reduce all unnecessary radiation exposures. The size of the population at risk, and the possible consequences of failures on our part are such that we cannot afford to await more detailed and precise knowledge. As new information comes out of vigorously prosecuted research programs, suitable adjustments can be made in standards, protective procedures, and public health efforts. Only thus can we feel confident that the people of this country can continue to enjoy the many health and social benefits inherent in radiation producing devices and materials. (C.H.)

33402 RADIOBIOLOGICAL AND PHYSICOCHEMICAL PROPERTIES OF 5-BROMODEOXYURIDINE-LABELED TRANSFORMING DNA AS RELATED TO THE NATURE OF THE CRITICAL RADIOSENSITIVE STRUCTURES. Waclaw Szybalski and Zofia Opara-Kubinska (Univ. of Wisconsin, Madison). 35p. (CONF-456-6)

From 18th Annual Symposium on Fundamental Cancer Research and Cellular Radiation Biology, Houston, Tex., Mar. 1964.

Bacillus subtilis cells grown for two generations in the presence of the thymidine analog, 5-bromodeoxyuridine (BUdR), yielded two classes of DNA: unifilarly labeled, or hybrid, and bifilarly labeled DNA molecules, in which up to 100% of the thymidine residues was replaced by BUdR on only one or on both DNA strands, respectively. The sensitivities of these two classes of labeled DNA molecules to x rays, to three selected wavelengths of ultraviolet light, to subcritical heat inactivation, to critical heat inactivation or melting, and to hydrodynamic shear were assayed and compared with the sensitivity of normal unsubstituted DNA. Genetic transformation toward indole (IND), histidine (HIS), leucine (LEU) and phenylalanine (PHE) prototropy served as the assay system for DNA survival. The radiation survival of control and BUdR-labeled B. subtilis cells was also determined. It was concluded that bifilarly BUdR-labeled DNA is up to 5, 21, and 26 times more sensitive than the unlabeled DNA to x rays, and to short (254 mμ) and medium (300 to 340 mμ) wavelength ultraviolet light, respectively. Similarly, BUdR sensitized DNA also to subcritical heat inactivation and to hydrodynamic shear. Unifilar labeling results in intermediate sensitization. The PHE, IND, and LEU markers in that order are progressively more sensitive to all the agents tested with the exception of critical heat inactivation, with the IND marker inactivated at the lowest temperature, followed by LEU and PHE. The degree of BUdR sensitization varied somewhat for the individual markers, but differences were small especially for unifilarly labeled DNA. In contrast to other types of inactivating agents, an actual increase in resistance to long wavelength (350 to 390 mμ) ultraviolet light and to critical heat inactivation was observed with BUdR-labeled DNA. Sensitivity of transforming activity to x rays and to short and medium wavelength ultraviolet light depended directly on the size of the DNA fragments. On the average, cells which survived exposure to BUdR through one replication cycle were sensitized to ultraviolet (254 mμ) and to x rays to the same extent as the unifilarly labeled DNA extracted from these cells, attesting to the role of DNA as the principal radiosensitive cell component. This conclusion is independent of the actual mechanism of radiosensitization by the incorporated BUdR, i.e., whether it increases the intrinsic lability of the DNA structure or whether it interferes with some DNA repair process. The notion that DNA is the critical radiosensitive cell component was further corroborated by the observation that the radiosensitivity of bacterial and mammalian cells is a function of the degree of DNA-labeling by BUdR, while BUdR not incorporated into DNA has no effect on the sensitivity of the cells. (auth)

Radiation Effects Therapy and Countermeasures

33403 CERTAIN PROBLEMS OF THE TRANSPLANTATION OF BONE MARROW IN RADIATION SICKNESS. K. K. Zaytsev. Arkh. Patol., 26: 3-15(Mar. 1964).

Several cases in which transplantations of bone marrow hemopoietic cells were successfully carried out are described. A marked improvement in the condition of the patients was noted within a month after the transplantation of the hemopoietic cells; active proliferation of the cells set in. Although most of the patients are now still living, it is too early to establish a definite prognosis. As yet, there are not sufficient data to support the efficacy of bone-marrow hemopoietic cell transplantation as a cure of radiation sickness. The problem in the main is still in the experimental stage. Bone-marrow transplantation, however, cannot be regarded as the only means of treating radiation sickness. (TCO)

33404 CONCENTRATION OF OXYGEN IN TISSUES AND ITS RELATION TO RADIOSENSITIVITY. A. Vacek and E. Davidova (Inst. for Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 13: 272(1964).

The concentration of oxygen in tissues is 1.7 to 2 times lower than in the atmosphere. The increase of oxygen increases the radiosensitivity. Experience with animals subjected to adrenalectomy, and the influence of cortisone upon radiosensitivity of such animals are discussed. (OTS)

33405 CONTRIBUTION TO THE PROBLEM OF THE ORIGIN OF GIANT CELLS AFTER IRRADIATION. M. Klimek and M. Vlasinova (Inst. for Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 13: 273-4 (1964).

The cause of gigantic cells formation is the loss of the ability of the cells to divide themselves. The development of gigantic cells of the strain HeLa and the influence of the protective substances cysteamine, amino-ethyl isothio uranium, and of the radiosensitizing substances 5-bromo-desoxyuridine and 5-iodo-desoxyuridine was studied. Up to an irradiation of 800 r the number of gigantic cells is in proportion to the amount of irradiation; between 900 and 20,000 there is no discernible influence. (OTS)

33406 RADIOPROTECTIVE ACTIVITY OF NITROGENOUS HETEROCYCLIC COMPOUNDS. Renaud Rinaldi and Yvette Bernard (CEN, Grenoble, France). Compt. Rend., 258: 6251-3(June 22, 1964). (In French)

A study of the radioprotective properties of 15 derivatives of imidazole showed that benzimidazole has considerable radioprotective effects. This compound permits the survival of 90% of mice exposed to a lethal dose. The maximum effects are obtained by administration 5 min before irradiation, but administration 1 hr before exposure protects 45% of the animals. The dose reduction factor is

1.33. Benzimidazole causes considerable hypothermia (– 8°C after 60 min), but no correlation could be established between this and the radioprotective effects. (tr-auth)

33407 EFFECT OF RADIOPROTECTORS ON THE RADIOLOGICAL TREATMENT OF CANCERS. J. R. Maisin (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Compt. Rend. Soc. Biol., 158: 193-7(1964). (In French)

The effect of AET (2-β-amino-ethylisothiourea) on the survival of mice grafted with Landschutz (hyperdiploidy Ehrlich) cells in the thigh or the peritoneal cavity and irradiated with x rays was studied. The experimental conditions are described, and the results are discussed. Although AET protects the ascites cells, it was possible under the particular experimental conditions (irradiation of a large body surface in addition to local irradiation of the tumor) to increase substantially the survival of the protected mice with respect to non-irradiated controls and to mice irradiated without protection. (J.S.R.)

33408 RADIOPROTECTION OF THE COAT OF SMALL MICE BY ANOXIA. M. L. Beaumariage (Universite, Liege). Compt. Rend. Soc. Biol., 158: 197-200(1964). (In French)

A study was made on 8-day old black C57 mice to determine if epilation by x radiation was sensitive to anoxia induced by irradiation in oxygen-poor atmosphere or by interruption of the blood circulation in a given skin region during exposure. The mice were exposed to radiation doses of 550, 700, 900, 1000, and 1100 R. The results showed that the epilation threshold dose was 550 R for mice irradiated in normal air. Irradiation in an oxygen-poor atmosphere (5% oxygen) was followed by protection against epilation, which varied as a function of the dose and increased the threshold dose to 1100 R. The presence of a tourniquet on one of the paws during irradiation in air was followed by radioresistance localized at the level of the paw. (J.S.R.)

33409 RADIOPROTECTIVE EFFECTS OF THE CHLORIDES OF Na, Ca, AND Mg ON THE GROWTH OF BARLEY. C. Gillet and G. Lennes (Universite, Liege). Compt. Rend. Soc. Biol., 158: 205-10(1964). (In French)

The modifications introduced in the growth of irradiated barley by pretreatment with alkaline or alkaline-earth salts were studied in order to define the limits of their radioprotective effects and to interpret their effective mechanism. Twelve hours before irradiation barley seeds were placed in 0.5M solutions of NaCl, $MgCl_2$, or $CaCl_2$. The seeds were then exposed to doses from 250 to 12,000 R. The seeds were germinated under normal conditions. The results show that the radioprotective effect obtained is very strong. The growth of the coleoptile and the first leaf of the treated seeds was significantly greater than that of seeds placed in distilled water. (J.S.R.)

33410 THE EFFECT OF RNA AND MONONUCLEOTIDES ON THE RESTORATION OF RADIOLESIONS AND ON THE RADIORESISTANCE IN SACCHAROMYCES CEREVISIAE. J. Maisin and E. van Duyse (Institut du Cancer, Louvain, Belg.). Compt. Rend. Soc. Biol., 158: 395-7(1964). (In French)

Yeast cultures were exposed to x-ray doses from 35,000 to 85,000 R. After irradiation the colonies were placed on a medium enriched in RNA at a dose of 5 γ/ml. The addition of the RNA increased the viability of the cultures up to exposures of 55,000 R. The restoration of radiolesions resulting from 60,000-R exposures appeared, however, impossible. The addition of the alkaline hydrolyse of RNA to the culture had the same effect on the culture survival as the addition of RNA. (J.S.R.)

33411 RADIOPROTECTIVE PROPERTIES OF THE ADRENOCORTICOTROPIC HORMONE (ACTH). L. V. Oriova, S. P. Klimova, and V. M. Rodionova (Inst. of Biological and Medical Chemistry, Academy of Sciences, USSR). Med. Radiol., 9: No. 6, 19-22(June 1964). (In Russian)

The radioprotective properties of the adrenocorticotropic hormone were investigated in albino rats with different doses and various preparations of ACTH. It was found that ACTH preparations with a prolonged action increased the survival of irradiated animals when introduced to rats in a daily dose of 0.25 and 1 unit for a period of 6 days before irradiation. (auth)

33412 THE USE OF LAGOCHYLUS IN ACUTE RADIATION INJURIES INDUCED BY INJECTION OF Po^{210}. S. M. Mikhailovich. Med. Radiol., 9: No. 6, 43-6(June 1964). (In Russian)

Lagochylus, a new styptic, was used in experiments on mice, rats, and dogs subjected to a single subcutaneous introduction of polonium (0.1 to 0.05 millicurie/kg body weight). It was found that the isolated use of lagochylus proved to be insufficiently effective in respect to the life expectation of experimental animals, however it exerted a positive influence on the restoration of processes of permeability and skin capillary fragility. The effect was best when lagochylus was combined with unithiol. The latter is a good agent facilitating the excretion of polonium from the organism. A combination of lagochylus and unithiol produced an effective result on the course of the radiation reaction. (auth)

33413 CIGEROL AND LINOL TREATMENT OF EXPERIMENTAL RADIATION INJURIES OF THE SKIN. A. T. Sosnovskii (Minsk Medical Inst., USSR and Belorussian Research Inst. of Research, Dermatological and Venereal Diseases, USSR). Med. Radiol., 9: No. 6, 46-7(June 1964). (In Russian)

During cigerol treatment of radiation ulcers in 28 guinea pigs caused by unfiltered x rays, a complete recovery took place after 62.3 ± 1.9 days. During linol treatment in 27 guinea pigs the radiation ulcers healed after 76.6 ± 2.54 days. The difference in the terms of ulcer healing during the local use of cigerol and linol is statistically significant. Cigerol is more effective than linol in the treatment of radiation ulcers. (auth)

33414 THE QUESTION OF THE RADIOPROTECTION EFFICIENCY OF HISTAMINE IN MICE. H.-J. Melching, C. Streffer, H.-A. Ladner, and U. Allert (Universität, Freiburg i. B.). Naturwissenschaften, 51: 266(1964). (In German)

The radioprotection efficiency of histamine in mice was investigated in order to obtain initial data for the determination of the possible mechanism of this substance. White male mice were exposed to x-ray doses of 690, 810, 955, and 1050 R. The survival of the mice receiving histamine dihydrochloride or histamine diphosphate 15 min before the irradiation was determined 30 days later. The calculation of the dose effect curve gave a dose reduction factor of 1.83 for $LD_{50/30}$ for the dihydrochloride and 1.81 for the diphosphate. The results showed a good protective effect in the sense of an increase of the survival rate could be obtained with histamine. The results suggest that the action mechanism of histamine is similar to that of cysteine, cysteamine, or serotonin. (J.S.R.)

33415 THERAPEUTIC MODIFICATIONS OF THE RADIATION DAMAGE IN RATS BY SPLENECTOMY.

H.-A. Ladner and J. Schneider (Universität, Freiburg i. B.). Naturwissenschaften, 51: 266-7(1964). (In German)

The therapeutic effect of a splenectomy after whole-body irradiation was investigated in male Wistar rats. The rats were exposed to doses of 810, 890, 955, and 1050 R, with splenectomy 1, 3, and 24 hrs after irradiation. The survival rate was determined 30 days after irradiation. The results showed that splenectomy 1 hr after irradiation with 810 and 890 R gave only a slight increase in the survival rate, but an increase of the survival rate in animals exposed to 955 R was obtained by splenectomy 1 hr after irradiation. No therapeutic effect was detected in rats exposed to 1050 R. The highest survival rate was observed at an interval of 24 hr between irradiation with 955 R and splenectomy. (J.S.R.)

33416 EFFECT OF CERTAIN HORMONES ON HEMOPOIESIS AND THE SURVIVAL RATE OF IRRADIATED MICE OF STRAIN S 57/6. E. E. Ogandzhanyan, E. A. Pereyshvili, and I. G. Batikyan (Lenin Medical Inst., Moscow and Radiobiology Section, Academy of Sciences, Armenian SSR). Probl. Endokrinol. i Gormonoterap., 10: No. 2, 107-10(Mar.-Apr. 1964).

Investigations were made to determine the prophylactic and therapeutic effect of testosterone propionate, synestrol, and the combination of synestrol and splenin on the blood picture and the survival rate of black mice strain S 57/6 irradiated with doses of 600 R. The animals were divided into a control group, and several experimental groups to which the preparations were administered separately or in combinations prior to irradiation. Observations of 28 days established that the therapeutic application of splenin in combination with synestrol led to the early restoration of the number of leukocytes in the peripheral blood, and intensified the regenerative processes, increasing the survival rate of the animals by 49.9%; the therapeutic application of splenin alone increased the survival rate of the animals from 18.7 to 50%; the prophylactic application of splenin reduced the mortality rate of the irradiated mice from 81.3 to 66.7%; the therapeutic and prophylactic application of testosterone propionate had no effect on radiation sickness and failed to increase the survival rate of the animals; the therapeutic application of synestrol induced 100% lethality of the mice. (OTS)

33417 THE EFFECTIVENESS OF DIETHYLENE TRIAMINE PENTAACETIC ACID IN THE CASE OF CONTAMINATION BY ABSOLUTELY LETHAL DOSES OF CERIUM-144. L. A. Il'in, N. I. Lukash, and T. A. Norets (Scientific Research Inst. of Health Physics, Leningrad). Radiobiologiya, 4: 435-9(1964). (In Russian)

Diethylenetriaminepentaacetic acid (DTPA) is one of the best agents for accelerating the removal of the radioisotopes Ce, Y, La, Zn, and Pu from an organism. In order to evaluate the effectiveness of this compound, the survival rate of animals subjected to internal exposure at the lethal dose level was determined on the basis of the influence of the complexing agent on the tissue dose. Male white mice were used for the tests, introducing subperitoneally the ^{144}Ce, in equilibrium with its daughter ^{144}Pr, in the form of a $^{144}CeCl_3$ solution; a 4π counter was used to measure the absolute β activity. In order to take into account the possible incorporation of Ce, stable $CeCl_3$ was administered to one of the control groups. The DTPA was introduced in the form of a solution of its trisodium–calcium salt first, 10 minutes before the contaminating agent and again during the following 4 days, repeating the process after an interruption of 3 days. The results showed that such parenteral contamination of the mice with 14.6 μC/g of $^{144}Ce + ^{144}Pr$ resulted in the death of 100% of the animals within 10 days; 90% died within the first 5 days. Treatment with DTPA was found to protect all the animals for 100 days after an internal exposure. The protective action is based on the acceleration of the removal of ^{144}Ce from the organism, causing a marked reduction of the internal tissue dose. (TTT)

33418 A RADIOPROTECTIVE THIOSULPHATE-BETAINE. (to Thiokol Chemical Corp.). British Patent 964,239. July 22, 1964. Priority date Dec. 22, 1961, United States.

A radioprotective compound is described which is water-soluble, nontoxic at the dosages which provide radioprotection, and is easily prepared. The compound is 2-N-methyl-ammonium-ethylthiosulfuric acid and can be prepared by reaction of N-methyl-β-chloroethylamine hydrochloride with an alkali metal thiosulfate. Examples are given of its preparation, and data are given on its radioprotective activity in mice exposed to 800 r x rays, as compared to that of similar compounds. (D.L.C.)

Radiation Hazards and Protection

33419 WEIGHED GONADAL DIAGNOSTIC ROENTGEN-RAY DOSES IN A TEACHING HOSPITAL WITH COMMENTS ON X-RAY DOSAGES TO THE GENERAL POPULATION OF THE UNITED STATES. Robert N. Cooley and Lucas B. Beentjes (Univ. of Texas, Galveston). Am. J. Roentgenol., Radium Therapy Nucl. Med., 92: 404-17(Aug. 1964).

Some of the literature regarding the assessment of annual genetic dose to the general population of the United States, United Kingdom, and Sweden, is reviewed. All the x-ray procedures performed in a medium-sized teaching hospital at the University of Texas Medical Branch over a $2^1/_2$ year period (219,590 examinations) were classified according to type of examination, age, and sex. The average gonadal dose delivered during the performance of each of these procedures was determined from direct measurements from ionization chambers placed on the scrotum or in the rectum or vagina; from tables relating the gonadal dose to skin dose; and by measuring doses administered to phantoms. (auth)

33420 RADIOBIOLOGICAL PROBLEMS POSED BY THE UTILIZATION OF RADIOISOTOPES. J.-A. Henry. Bull. Inform. Assoc. Belge Develop. Pacifique Energie At., 9: No. 49, 20-5(Apr. 1964). (In French)

The radiobiological problems posed by the use of radioisotopes are illustrated by a consideration of the problems in the use of radioiodine and the processing of plutonium. Areas in which further study is necessary are indicated. (J.S.R.)

33421 SOME ISSUES OF RADIATION PROTECTION IN THE THERAPEUTIC APPLICATION OF RADIOACTIVE IODINE. M. I. Enikeev. Gigiena i Sanit., No. 1, 44-9(1964).

Certain aspects of the radiation effect produced on personnel of medical institutions by ^{131}I used for treatment of thyrotoxicosis are considered. Available data show medical personnel are exposed to radiation doses well below the maximum permissible level. (auth)

33422 DENTAL MANAGEMENT OF THE ORAL EFFECTS OF RADIOTHERAPY. John E. Robinson (Univ. of Chicago). J. Prosthetic Dentistry, 14: 582-7(May-June 1964).

The clinical entity of radiation mucositis and glossitis, which develops in conjunction with such radiation therapy

about the region of the head, is described with reference to case material. (TCO)

33423 THE MODIFICATION OF THE TERATOGENIC AND LETHAL EFFECTS OF IRRADIATION TO THE MAMMALIAN FETUS. Robert L. Brent (Jefferson Medical Coll., Philadelphia). p.451-62 of "The Proceedings of an International Symposium on the Effects of Ionizing Radiation, in the Reproductive System." New York, Pergamon Press, 1963.

The results of modifying the effects of x irradiation are discussed with specific reference to the embryo of rats and mice. The conditions or agents which tended to reduce the effects of irradiation were the sulfhydryl group of compounds, hypoxia, uterine vascular clamping, embryonic shielding, irradiation at reduced ambient temperature, and fractionation and protraction of the dose of irradiation under certain circumstances. The conditions or agents which did not reduce the effects of irradiation were bone marrow, liver or spleen infusions, post-irradiation, placental shielding on the 12th day, maternal shielding on the 9th day of gestation, ovarian shielding on the 6th day of gestation, progesterone injections throughout pregnancy, and in certain instances protraction and fractionation of the dose or irradiation. (auth)

33424 PHYSICAL MEASUREMENTS AND CLINICAL FINDINGS OF PERSONS WITH RADIUM BURDENS. H. Muth and E. Oberhausen (Universität, Saar, Homburg, Ger.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/61, 17p. (CONF-448-25)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

Results of physical measurements and some clinical findings on persons with radium burdens are reported and discussed. Ten workers in the dial painting industry, two chemists, who have been working for between 10 and 20 years in the radium industry, one technician, who has been working for over 20 years with high-emanation radium preparations, and one person with high radium intake of unknown history were measured in a whole-body counter for evaluation of the body burdens of ^{226}Ra and $^{228}Ra + {}^{228}Ac$. In some cases the radon concentration of expired air was also measured. For four of the measured persons the ^{226}Ra burden is of the order of the maximum permissible amount (MPA: 10^{-7} C) or more. In one case the burden amounts to more than three times the MPA, (3.4×10^{-7} C), in another case to more than 100 times the MPA (160×10^{-7} C). In one case the $^{228}Ra + {}^{228}Ac$ burden exceeds the MPA (6×10^{-8} C in bone). The measured radon concentrations in the expired air were used to calculate the excretion rate of radon. The average was 67%. Clinical findings with some of the measured persons are related to the measured body burdens. The patient with the high body burden of 160×10^{-7} C ^{226}Ra shows heavy bone changes leading to spontaneous bone fractures. The blood picture shows a decrease in the number of erythrocytes and a low hemoglobin content but puncture of the sternum indicates normal hematopoiesis. It seems that the low number of erythrocytes is caused by chronic nephropathia, the reason for which might be an additional intake of uranium because uranium was found in the urine by gamma spectroscopy. The results are discussed with respect to the MPA of ^{226}Ra recommended by the International Commission on Radiological Protection. (auth)

33425 MEASUREMENT OF THORON IN BREATH OF THOROTRAST PATIENTS AND EVALUATION OF THE RESULTS. R. Grillmaier, H. Muth, and E. Oberhausen (Universität, Saar, Homburg, Ger.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-62/62, 21p. (CONF-448-26)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

Thoron was continuously measured in the expired air of 45 thorotrast patients by flowing the breath through an ionization chamber. A short description of the method and equipment is given, and the results are discussed. The average value of the rate of thoron being exhaled depends on the kind of thorotrast depot. This value is higher if the ThO_2 is deposited only or mainly in the reticuloendothelial system (RES) and smaller if there are bigger depositions outside the RES. The reason for these differences in exhalation rates is discussed. The rate of thoron escaping from the site of deposition into blood and the rate of thoron in blood which is excreted by breath is determined. The fraction of thoron decaying inside the lungs is estimated. The mean value of all measurements of exhaled thoron is 7%. For depositions mainly in the RES the mean value is 9%, for depositions outside the RES 4%. About 20% of thoron escapes from the site of formation. About 9% decays in blood and about 4% in the lungs. (H.M.G.)

33426 MEASUREMENTS AND CLINICAL FINDINGS ON THOROTRAST DEPOSITS IN THE KIDNEY. E. Oberhausen, H. Muth, and R. Grillmaier (Universitat, Saar, Homburg, Ger.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/63, 18p. (CONF-448-27)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

Under normal conditions all thorotrast is swept out of the kidney with the urine. But if it was applied under higher pressure or if there existed an infection of the kidney, part of the thorotrast might be deposited in the tissues. It is possible that a high number of these deposits is not recognized in x-ray pictures because they look very similar to calcium deposits. Seven such cases were found in the last years. When there was only a deposit in one kidney, which was the case in six patients, the organ was taken out. Histological examination showed five carcinomas and in one kidney enormous degenerative changes. According to the observations the time necessary for carcinoma development is between 20 and 25 years. In two cases the patient was monitored in the whole-body counter to measure the radioactive substances in the urine and the thoron in the breath. All measurements were done before and after nephrectomy. The gamma rays of the isolated organ itself were also measured. From these measurements, an evaluation of radiation dose is possible. (H.M.G.)

33427 THE TIME ANALYSIS AND FREQUENCY DISTRIBUTION OF CESIUM-137 FALLOUT IN MUSCLE SAMPLES. W. H. Ellett and G. L. Brownell (Massachusetts General Hospital, Boston). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/64, 15p. (CONF-448-28)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

A meaningful evaluation of the nuclear fallout hazard can only be made if the frequency distribution of radioactivity in the population is known. Attempts to determine the shape of the distribution curve from Kulp's data on ^{90}Sr in children's bones have met limited success because of the small sample size and lack of strontium-90-calcium equilibrium in bone. To overcome these limitations, the cesium-137 contents in approximately 900 muscle samples were measured. The tissue samples were removed during postmortem operations from January 1959 to August 1963. The

use of cesium-137 as a fission product monitor assures that all members of the group, regardless of their age, were essentially in equilibrium with the radioactive environment at the time of death. Average cesium-137 in the samples was relatively constant throughout 1959, decreased a factor of two during 1960, and remained relatively stable until the early summer of 1962. Since mid-1962 the average level of cesium-137 radioactivity in the samples steadily increased and was fourfold greater than the 1962 minimum by the summer of 1963. Time-independent histograms of the data were assembled by fitting a polynomial to the raw data (sample radioactivity as a function of data of death). These data were tested statistically against normal, lognormal, and gamma frequency distributions. Results indicate that the experimental distribution is definitely not gaussian and is best fitted by a gamma distribution. By using the empirically derived gamma distribution it is possible to predict the fraction of the population having N times the average activity for any level of fallout. This model was tested for the fourfold increase in activity since mid-1962 and was found to accurately predict the present distribution of cesium-137 between individual members of the sample population. (auth)

33428 FORMULATION OF RELATIONSHIPS BETWEEN THE RADIATION EXPOSURE OF TISSUES AND THE EXCRETION RATE OF NUCLIDES. E. E. Pochin (University Coll. Hospital Medical School, London). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/81, 17p. (CONF-448-31)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

The organization of protection against undue occupational exposure to internal radiation involves several processes: decisions as to the highest dose rates, for the body or for particular organs, that can be regarded as permissible; estimation of the intakes and body burdens that cause any such dose rates to be reached or sustained; monitoring of exposed individuals to determine what fraction of a permissible body burden of any nuclide is retained in the body; and techniques of monitoring by whole-body counting or by data on excretion or exhalation rates. Several major problems are involved: for most radionuclides, insufficient metabolic data are available to link tissue dose rates either with body burdens or with excretion rates; the large variability between different subjects in physiological functions such as excretion or clearance rates limits severely the inferences that can be made from isolated human observations, and restricts also the deductions as to body burden that can be drawn from the excretion rates observed in any individual; the complex variation of excretion rate with time after a single intake of many nuclides prevents any direct deduction of body burden from excretion rate when the time course of intake is unknown; many radionuclides of particular importance may show initial rapid excretion of the fraction of intake which is not so concentrated, and much slower and more prolonged excretion of the retained part; and the formulations of ICRP, which are commonly based on simple exponential models, may be inappropriate for relating excretion rate to body burden in any individual in the case of nuclides which mix in, and are excreted from, multicompartment systems in the body. These situations require special review in the light of evidence as to the earliest phases of turnover. (H.M.G.)

33429 FIRST RESULTS OF A SYSTEMATIC STUDY OF INTERNAL CONTAMINATION RESULTING FROM RADIOACTIVE FALLOUT. P. Pellerin, J. P. Moroni, and M. L. Remy. Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/80, 11p. (CONF-448-3). (In French)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

The levels and evolution of activities in workers in the nuclear industry, the population at large, and workers in certain conventional industries (particularly engine mechanics for transcontinental jet aircraft) were followed from late 1961 through early 1964. Contamination by fission products with short and average lives was considered, together with body burdens of ^{137}Cs and ^{90}Sr. The activity of ^{137}Cs in milk was followed over the same period. (D.C.W.)

33430 A CONSIDERATION OF BASIC RADIATION PROTECTION GUIDES APPLICABLE TO THE GENERAL POPULATION. [Paul C. Tompkins]. 15p. (CONF-623-1)

From American Medical Association Congress on Environmental Health Problems, Chicago, May 1964.

Radiation protection guides applicable to the general populations are reviewed with emphasis on those issued by the Federal Radiation Council. It is pointed out that the introduction of the non-threshold, statistical risk concept has had the effect of putting scientific judgments of dose-effect relationships and political judgments concerned with national welfare on a somewhat equal footing particularly when exposure of the general population is a factor in proposing basic Radiation Protection Guides. Once a consensus on an acceptable balance between the benefit of an activity leading to radiation exposure and the biological risk associated with that exposure has been reached, one has an acceptable standard. However, one also has a standard that cannot be easily changed in either direction. It cannot be decreased without decreasing the benefits due to the greater burden of meeting the requirements and it is possible to lower them far enough to eliminate any practical benefit whatsoever. Also, they cannot be raised without imposing a greater risk than that which was considered acceptable even though from scientific knowledge it is not known what the effect actually is at either level. Applications of the Radiation Protection Guides issued by the Federal Radiation Council in estimating radiation hazards from fallout fission product contamination of the environment are discussed. (C.H.)

Radiotherapy and Radiodiagnosis

33431 (TID-20856) THE USE OF THERMAL AND EPITHERMAL NEUTRONS IN THE TREATMENT OF NEOPLASMS. Final Report. William H. Sweet (Massachusetts. General Hospital. Neurosurgical Service, Boston). [1964]. Contract AT(30-1)-1093. 30p.

When ^{10}B captures a slow neutron the resultant compound nucleus disintegrates at once to yield a Li atom, on α particle, and 2.4 Mev of energy shared between these two relatively large masses. With this energy and size they travel about 10μ in living tissue so that the destructive effect is limited to the cell containing the disintegrating B atom or to its immediate neighbor. The use of this reaction for the differential destruction of tumor cells was investigated, with emphasis on applications in the treatment of malignant brain tumors. The advantages and disadvantages of B slow neutron capture therapy are reviewed. Methods for neutron dosimetry, the pharmacology of B compounds, and tumor/brain boron ratios are discussed. Clinical data are included for 19 patients with a diagnosis of glioblastoma or medulloblastoma treated by this method. (C.H.)

33432 BRAIN-TUMOR DIAGNOSTICS WITH POSITRON RADIATION. O. Wilcke. Acta Neurochir., 10: 301-19 (1962). (In German)

The results of investigations with the positron scanner in patients injected with ^{74}As or ^{64}Cu are described. In two hundred and eighty-six patients investigated, of whom 160 had cerebral tumors, 76% of the brain tumors were localized. Meningiomata, abscesses, and metastases showed the most positive results. The certainty with which tumors may be excluded is about the same as the accuracy with which they are recognized. From these experiences, it was concluded that the positron scanning technique is a welcome addition to diagnosis by contrast media. (C.H.)

33433 SCINTILLATION SCANNING OF KIDNEYS: A PITFALL OF INTERPRETATION IN RENAL INSUFFICIENCY. Maria G. Buse, Dyrc F. Sibrans, and John Buse (Medical Coll. of South Carolina, Charleston). Ann. Internal Med., 60: 857-65(May 1964).

Use of renal scanning with chlormerodrin-^{203}Hg is questioned in uremic patients. In renal scans performed on four patients with uremia 50 min after injection of 150 μC of chlormerodrin-^{203}Hg, the right kidney was obscured by the increased radioactivity of the liver. Increasing the time interval between injection of contrast material and scan did not improve resolution. Since visualization of the liver on a renal scan suggests the presence of renal failure, it is recommended that such scans in uremic patients should be interpreted with caution. (H.M.G.)

33434 PLANNING RADIATION TREATMENT ON THE COMPUTER. Theodor D. Sterling and Harold Perry (Univ. of Cincinnati). Ann. N. Y. Acad. Sci., 115: 976-97(July 31, 1964).

Once digitizing of per cent dose distributions are accomplished, either by methods of hand digitizing or by fitting equations to dose surfaces, the computer can be used to print out the dose distribution resulting from any multiple field arrangements of treatment beams. This makes it possible to plan and replan treatments according to each individual patient's needs. Furthermore, the radiologist now has the opportunity to study the effect of different treatment conditions on dose distribution. It is shown that some constellation of treatment beams lead to unique patterns of high and low dose areas. These patterns may be used to fit particular patient need and to ensure optimum treatment situations. (auth)

33435 PATIENT SIMULATION IN X-RAY THERAPY. William Siler, Frank Ritter, and John S. Laughlin (Memorial Sloan-Kettering Cancer Center, New York). Ann. N. Y. Acad. Sci., 115: 1038-48(July 31, 1964).

A mathematical model is described for use in planning x ray therapy of tumors that permits simulating the treatment of the patient on either a digital or an analog computer. (C.H.)

33436 A NUCLEAR NEEDLE FOR USE IN NEUROSURGERY. S. Mullan, P. V. Harper, E. Tani, G. Vailati, and K. A. Lathrop (Univ. of Chicago). J. Neurosurg., 20: 940-7(1963).

Fifty-four mC of strontium-90 were sealed hermetically in the terminal 6 mm of a 19-gauge stainless-steel needle. Measurements of dose surrounding this source were made in a phantom of lucite (which is very slightly denser than tissue). One hundred experimental lesions were made in brains of animals and were examined histologically up to 240 days after insertion. Lesions following periods of irradiation of greater than 30 min are unsatisfactory because of hemorrhage into the necrotic area. Lesions following irradiations of less than 30 min are predictable in size. There is an inner area of necrosis which reaches its maximum by the 3rd day, middle area of degeneration which reaches maximum activity by the 12th day, but in which degeneration continues up to the 60th or even the 90th day and an outer area of edema, which probably is without physiological significance. These zones were measured and the 15-minute lesion has been discussed in detail. (Excerpta Med., Sect. XXIII, 1: No. 6 (June 1964))

33437 EVALUATION OF THE RESIN UPTAKE OF I^{131} TRIIODOTHYRONINE AS A TEST OF THYROID FUNCTION. Edith H. Quimby and Elizabeth Hiza (College of Physicians and Surgeons, New York). J. Nucl. Med., 5: 489-99(July 1964).

An in vitro test of thyroid function was evaluated in a series of about 1000 measurements. The test consists in adding to the patient's serum a known amount of ^{131}I labeled triiodothyronine, mixing this with an ion-exchange resin, and measuring the amount of radioactive iodine absorbed by the resin. All uptake or absorption values are related to that obtained with a sample from a large pool of mixed sera (chemistry laboratory or blood bank) which is assumed to represent the normal individual. On the basis of the reading of this sample as 1.0 values from 0.80 to 1.30 indicate euthyroidism. Above 1.30 the indication is for hyperthyroidism and below 0.80, for hypothyroidism. In a series of 383 individuals clinically euthyroid, 3 per cent gave unduly high readings and 4 per cent unduly low. This is better than would be expected of the 24-hour ^{131}I uptake test. Of 57 hyperthyroids, 4 per cent gave readings in the euthyroid range; of 72 clinically hypothyroids, 14 per cent gave readings in the euthyroid range; (this is comparable to the ^{131}I uptake). Adolescents and children give readings in the adult euthyroid region. The very young children tend to be in the lower part of the range; the teen-agers fall in the center. Very early in pregnancy the value for the euthyroid woman drops into the low hypothyroid range and remains there until a few weeks post-partum. It is not suggested that this test replace the 24-hour uptake, or any other currently employed test. It is an addition to the battery of tests available. It does have the outstanding advantage of not being influenced by previous medication with iodine. It is somewhat more difficult and time consuming than the standard uptake test, but no more so than the protein-bound iodine test. (auth)

33438 STUDIES ON DIAGNOSIS AND TREATMENT OF CANCER WITH RADIOACTIVE ISOTOPES. REPORT I. DIAGNOSIS OF ESOPHAGUS CANCER WITH RADIOACTIVE PHOSPHORUS (P^{32}). C. S. Koh (Seoul National Univ., Korea), Y. S. Chang, W. Y. Soh, J. K. Lee, M. Lee, S. K. Kim, E. H. Yoo, and C. J. Kim. Korean J. Internal Med., 6: 715-20(1963). (In Korean)

The diagnostic accuracy of ^{32}P was evaluated in three patients with esophagus cancer. The patients in fasting state were pretreated with morphine and atropine in order to reduce the saliva and mucus secretion. After the intravenous administration of ^{32}P in doses of 200 to 400 microcuries, the pharynx was topically anesthesized with 5% hydrochloric cocaine, which was followed by slow insertion of a micro-GM tube to the cardia portion of the stomach. The tube was then pulled out at an interval of 1 cm and the activity was counted or directly recorded on a ratemeter during 4 to 24 hours after the administration of ^{32}P. The differences of activity by 30% from normal was considered not to be significant. This method appeared to have advantages in that the presence of neoplastic tissues in the esophagus could be numerically or graphically detected

with more ease and preciseness, while esophagoscopy, which invariably needs proficient skills, is impossible in some cases. Moreover, the radiological study also infrequently misses the early cancerous changes especially of the esophago-cardiac portion. Phosphorus-32 seemed to be very valuable in overcoming the disadvantages encountered with such conventional diagnostic methods. (auth)

33439 EXPERIENCES WITH RADIOACTIVE COLLOIDAL GOLD IN THE TREATMENT OF PLEURAL EFFUSION CAUSED BY METASTATIC CANCER OF THE BREAST. Thomas W. Botsford (Peter Bent Brigham Hospital, Boston). New Engl. J. Med., 270: 552-5(Mar. 12, 1964).

Of various methods for ameliorating pleural effusion ^{198}Au was found to be a most effective, relatively simple palliative treatment. The theoretical advantages of ^{198}Au presented include: short half life; radiation spectrum; particle size; particle concentration; and the fact that it is in a fluid medium with many point sources of radiation. The mechanisms by which the diffuse radiation from ^{198}Au decreases the rate of formation of pleural effusion are probably a direct effect on the cancer cells in the fluid, an effect on the implants on the pleura, submesothelial fibrosis, and obliteration of serosal blood vessels. Disadvantages in the use of ^{198}Au are listed and it is concluded that despite the disadvantages of expense and radiation hazard, ^{198}Au is one of the best methods of treating malignant pleural effusion caused by carcinoma of the breast. (TCO)

33440 TECHNIQUE FOR DETERMINATION OF DIGESTIVE ABSORPTION OF IRON USING AN INERT RADIOACTIVE INDICATOR. Y. Najean and Nicole Ardaillou. Nouvelle Rev. Franc. Hematol., 3: 82-3(Jan.-Feb. 1963). (In French)

A double tracer technique is described for the determination of Fe absorption during digestion. The method uses ^{59}Fe and $^{131}BaSO_4$. Intestinal Fe absorption is calculated on the basis of the amount of SO_4Fe and ^{131}Ba eliminated. The method gave good results in animal studies and possible diagnostic applications are discussed. (C.H.)

33441 STUDY OF MEDULLARY CIRCULATION IN MAN BY AN ISOTOPIC TECHNIQUE. Y. Najean and F. Clément (Hopital Saint-Louis, Paris). Nouvelle Rev. Franc. Hematol., 3: 133-8(Jan.-Feb. 1963). (In French)

After the intra-medullary injection of $Na_2{}^{51}CrO_4$ to rabbits and human subjects there were two phases in the appearance of radioactivity at the periphery. The second was exponential and appeared to correspond with the period of diffusion and of equilibration between the substance injected and the vascular space. This did not vary in the pathological conditions studied. The first phase was very rapid and appeared to correspond with the direct intravascular introduction of the tracer: it therefore gives some indication of the medullary blood flow. It is greatly diminished in myeloid splenomegalies. (auth)

33442 REPRESENTATION OF THE PANCREAS BY SCINTOGRAPHY. C. Biagini, A. Centi Colella, and F. Pigorini (Università, Rome). Nuntius Radiol., 29: 935-9 (Dec. 1963). (In Italian)

Good representation of the pancreas was obtained in normal subjects by external scintillation counting after the administration of ^{75}Se-methionine. Diagnostic applications of the technique are discussed. (C.H.)

33443 IMAGE-RETAINING PANEL: AN EVALUATION OF ITS USE IN DENTISTRY. Albert G. Richards (Univ. of Michigan, Ann Arbor). Oral Surg. Oral Med. Oral Pathol., 16: 1317-25(Nov. 1963).

The possible value of the image-retaining panel to dentistry was examined. The image-retaining panel is composed of a thin layer of zinc cadmium sulfide phosphor sandwiched between two electrically conducting plates, the front one of which is transparent. A 60-v battery is connected to the two conducting plates to supply the direct current required to operate the panel. To determine the effect of x rays on the image-retaining panel, the maxillary anterior region of a skull was exposed, and an image was produced which was similar to a fluoroscopic image with all the gradations in density reversed from their normal appearance in a radiograph. In tests of the sensitivity of the image-retaining panel to the range of energies used in dental radiography, it was shown that images can be recorded by the panel with either 65 or 90 kvp. It is concluded that the advantages of the image-retaining panel in dentistry over the present radiographic films are few. Advantages and disadvantages are discussed. (TCO)

33444 THE DETECTION AND TREATMENT OF POST-IRRADIATIONALLY RECIDIVATED CANCERS OF THE CERVIX UTERI. Ronald K. Gary, José M. Sala, and John S. Spratt (Ellis Fischel State Cancer Hospital, Columbia, Mo.). Radiology, 83: 208-18(Aug. 1964).

The value of follow-up examinations in the detection of post-irradiation persistent or recurrent carcinomas of the cervix uteri is discussed. A 1962 study of 554 patients treated between 1950 and 1959 for carcinoma of the cervix uteri showed that persistent or recurrent cancer had developed in 299. Of these cancers, 58.7% were persistent and 40.7% were recurrent. The results of this study are analyzed for information on the time elapsed after irradiation when persistent or recurrent cancers become evident, the signs and symptoms, and the efficacy of additional treatment. (C.H.)

33445 STUDY OF SIMPLIFIED METHODS FOR CONSTRUCTION OF COMPLETE ISODOSE DISTRIBUTIONS IN ROTATIONAL COBALT TELETHERAPY. TRUNK: HORIZONTAL 360° CENTRAL ROTATION. Roy E. Summers, Joseph P. Concannon, and David P. Leone (Allegheny General Hospital, Pittsburgh). Radiology, 83: 231-42(Aug. 1964).

Various simplifications in construction of isodose distributions for cobalt-60 rotational teletherapy are described. An isodose plan prepared for a circular contour for a specific field size in the direction perpendicular to the axis of rotation could be used as the isodose distribution for contours of different size and shape with a reasonable degree of accuracy. Within all contours, linear relationships were found to exist between the position of each rotational isodose per cent line and the size of field perpendicular to the axis of rotation. Correction factors were developed to adjust the position of rotational isodose per cent lines derived for circular contours to give accurate position of rotational isodose per cent lines within contours of oval shape. A system involving the use of two graphs for the determination of the position of rotational isodose per cent lines has been described. Relatively accurate and complete rotational isodose distributions can be prepared in a minimum of time with this system. (auth)

33446 REMOTE AFTERLOADING WITH INTRACAVITARY APPLICATORS. Ulrich K. Henschke, Basil S.

Hilaris, and G. D. Mahan (Sloan-Kettering Cancer Center, New York). Radiology, 83: 344-5(Aug. 1964).

A procedure is described for the remotely-controlled insertion of radiation sources into previously inserted intracavity applicators. Small sources of high activity are cycled back and forth slowly during the treatment, and the method is applicable to the use of ^{60}Co, ^{137}Cs, ^{226}Ra, or ^{192}Ir sources. A schematic sketch illustrates the arrangement used for the treatment of cervical carcinoma. (C.H.)

CHEMISTRY

General

33447 (IA-893) ACTIVITIES OF THE CHEMISTRY DIVISION. M. Anbar (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Sept. 1963. 8p. (CONF-426-5)

From IAEA Study Group Meeting on Research Reactor Utilization, Athens, Sept. 1963.

A brief outline is presented of the activities of the Inorganic Chemistry, Nuclear Chemistry, and Radiation Chemistry departments of the Soreq Research Establishment. Analytical services, isotope separation, and industrial applications of isotopes are also considered. (D.L.C.)

33448 (IDO-14644) ADSORPTION OF YOUNG FISSION PRODUCTS ON VARIOUS SURFACES FROM NEUTRAL AND DILUTE ACID MEDIA: APPLICATION TO WATER SAMPLE COLLECTION FOR STEP PROGRAMS. Robert E. Foster, William J. Maeck, and James E. Rein (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Jan. 17, 1964. Contract AT(10-1)-205. 12p.

In the STEP reactor accident study programs, water samples and moisture-saturated atmosphere plateout samples will be submitted for analysis of various fission product nuclides. This study was undertaken to measure the adsorption of young fission products on various surfaces proposed for use in these programs. On all surfaces studied, the adsorption of fission products increased with contact time. The most strongly adsorbed nuclides are Mo–^{99}Tc and Te–^{132}I. The presence of complexing agents retarded the degree of adsorption. (auth)

33449 (NIRS-2(p.15-19)) CHEMISTRY. (Japan. National Inst. of Radiological Sciences, Tokyo).

Experiments on gamma radiation effects on stability of barium sulfate sol, chemical analysis and radioactivity determination of Co in Fe, radiochemical determination of ^{137}Cs in human urine, ion exchange equilibrium between Cs and phenol-sulfonic-acid-type cation exchange resin, concentration of radioruthenium in sea water by ferric hydroxide resin, recording of uv light absorbing spots on paper chromatograms, and protein-binding of carcinogenic aminoazo dyes are reported. (P.C.H.)

33450 (NYO-2757-4) ON THE DEVELOPMENT OF KRYPTON-85 AS A UNIVERSAL TRACER. Quarterly Report, November 1, 1963–January 31, 1964. (Parametrics, Inc., Waltham, Mass.). Contract AT(30-1)-2757. 13p.

Various materials were kryptonated: nichrome wire, $Ba(ClO_4)_2$, $CaSO_4$, and fine Fe_2O_3 powders. Progress is summarized for the determination of trace water in organic liquids using CaC_2 ^{85}Kr and of methane in air using kryptonated PtO_2. The release of ^{85}Kr with time from stressed, kryptonated nichrome wire was studied. (D.L.C.)

33451 (ORNL-3654) FABRICATION OF THE VERTICAL-ORIFICE TEFLON CAPILLARY OF A TEFLON DROPPING-MERCURY ELECTRODE. Helen P. Raaen and Ralph L. Clark (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 23p.

A procedure was developed for fabricating the vertical-orifice Teflon capillary of a Teflon dropping-mercury electrode (D.M.E.). The capillary will be used for rapid polarography of glass-corroding solutions. Special tools were designed and built for use in the fabrication. The fabrication procedure is a modification and extension of that developed earlier for making Teflon D.M.E. capillaries that have the orifice in the horizontal plane. By means of a micro drill press and a micro drill, the vertical orifice is drilled in a lapped vertical face of the capillary blank. During the drilling, the capillary blank is held in a special jig, which is mounted on the table of the drill press. If the desired orifice diameter is about 100 μ or larger, a micro twist drill is used; for smaller diameters, a micro pivot drill is used. Several capillaries that have orifice diameters of about 70 μ and 100 μ were made. (auth)

33452 (ORNL-P-145) RECENT DEVELOPMENTS IN DC POLAROGRAPHY. D. J. Fisher, W. L. Belew, and M. T. Kelley (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 117p. (CONF-599-3)

From 3rd International Congress of Polarography, Southampton, Eng., July 1964.

A summary is presented of the ORNL work in controlled-potential d-c polarography since mid-1959. Among the topics discussed are potentiostatic compensation, time-derivative d-c polarography, signal-to-noise ratio, resolution, and polarography in nonaqueous solvents. (D.L.C.)

33453 ADVANCES IN CATALYSIS AND RELATED SUBJECTS. VOLUME 14. D. D. Eley, Herman Pines, and Paul B. Weisz, eds. Advan. Catalysis, 14: 1-522(1963). New York, Academic Press, 1963. $16.00.

Information is included on: quantum conversion in chloroplasts; catalytic decomposition of formic acid; application of spectrophotometry to the study of catalytic systems; hydrogenation of pyridines and quinolines; flash desorption, field emission microscopy, and ultrahigh vacuum techniques in surface kinetics; and catalytic oxidation of hydrocarbons. Separate abstracts were prepared for the chapters on quantum conversion and surface kinetics. (P.C.H.)

For abstracts of individual papers see: 33218 and 33454.

33454 MODERN METHODS IN SURFACE KINETICS. FLASH DESORPTION, FIELD EMISSION MICROSCOPY, AND ULTRAHIGH VACUUM TECHNIQUES. Gert Ehrlich (General Electric Research Lab., Schenectady, N. Y.). Advan. Catalysis, 14: 255-427(1963).

A review is presented on macroscopic rate studies; field electron microscopy, field ion microscopy, and ultrahigh vacuum techniques in surface kinetics, 135 references are included. (P.C.H.)

33455 NUCLEAR AND RADIOCHEMISTRY. SECOND EDITION. Gerhart Friedlander, Joseph W. Kennedy, and Julian Malcolm Miller. New York, John Wiley and Sons, 1964. 593p. $10.75.

Information is included on: radioactivity; atomic nuclei; equations of radioactive decay and growth; interaction of radiations with matter; radiation detection and measurement; statistical considerations in radioactivity measurements; tracers in chemical applications; radioactive decay processes; nuclear models; nuclear reactions; sources of nuclear bombarding particles; techniques in nuclear chemistry; nuclear processes as chemical probes; nuclear energy; and nuclear processes in geology and astrophysics. Physical constants and conversion factors relativistic relations, thermal neutron cross sections, and a table of nuclides are appended. (P.C.H.)

33456 ISOTOPIC AND COSMIC CHEMISTRY. H. Craig, S. L. Miller, and G. J. Wasserburg, eds. Amsterdam, North-Holland Publishing Company, 1964. 575p. $15.00.

A comprehensive and detailed representation of new experimental results and recent theoretical developments in the applications of physics and chemistry to the problems of the earth, life, and space sciences is contained in 32 papers. Approximately two-thirds of the book is devoted to applications of stable, radioactive, and radiogenic isotopes to problems in biology, geology, and meteoritics; the remaining papers provide a unifying framework of related topics in these fields. Separate abstracts were prepared for 25 papers. For one paper previously abstracted in NSA see: 17: 25430. (L.B.S.)

For abstracts of individual papers see: 33226, 33257, 33258, 33259, 33783, 33784, 33785, 33786, 33787, 33788, 33789, 33790, 33791, 33792, 33793, 33867, 34013, 34396, 34397, 34398, 34399, 34400, 34401, 34402, and 34669.

Analytical Procedures

Refer also to abstracts 33769 and 33794.

33457 (AE-146) CONCENTRATION OF 24 TRACE ELEMENTS IN HUMAN HEART TISSUE DETERMINED BY NEUTRON ACTIVATION ANALYSIS. P. O. Wester (Aktiebolaget Atomenergi, Stockholm). 1964. 33p. (UDC-543-53)

By means of neutron activation analysis, human heart tissue from autopsy of 20 victims of traumatic accidents was investigated with respect to the concentration of 24 different trace elements. A recently developed ion exchange technique combined with gamma spectrometry was used, which permits simultaneous determination of a large number of trace elements. The following trace elements were determined quantitatively: Ag, As, Au, Ba, Br, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Hg, La, Mo, Pt, Rb, Sb, Sc, Se, Sm, Zn, and W. In some heart samples, Hf and Os were determined qualitatively. The mean and standard deviation are given for Cu, Fe, Se, and Zn. Since none of the other quantitatively determined trace elements were normally distributed, the median is given as the central value. When possible, comparisons with values from other investigations were made. No marked differences in the trace-element concentrations with age or sex could be detected. (auth)

33458 (BM-RI-6483) X-RAY SPECTROGRAPHIC ANALYSIS FOR TRACE QUANTITIES OF TANTALUM IN COLUMBIUM. Peter A. Romans, W. J. Niebuhr, and J. R. Hauger (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Feb. 1964. 15p.

With suitable instrumentation and techniques, it is possible to determine the presence of tantalum in columbium to 20 ppm. The selection of x-ray spectrographic instrumentation is discussed, and a technique is described for accomplishing the low level determination of tantalum. An ion-exchange method of separating tantalum from columbium is also described. (auth)

33459 (CEA-R-2428) CONTRIBUTION A L'ETUDE DE SOURCES LUMINEUSES DESTINEES AU DOSAGE ISOTOPIQUE DE L'URANIUM PAR SPECTROMETRIE D'EMISSION. (Contribution to the Study of Luminous Sources for Uranium Isotope Measurements by Emission Spectrometry). Jean Pierre Leichnam and Robert Capitini (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1964. 25p.

After a brief summary of results obtained with different hollow-cathode luminous sources, the reasons for which they cannot be more widely used are given: an insufficient luminosity when uranium oxides are used in the cathode hollow; the large amount of sample required when it is metallic; the impossibility of effecting a chemical purification of the sample. Electrodeless discharge tubes excited by high frequency, whose qualities (luminosity, stability, and rapidity of preparation starting from small amounts of sample in various chemical forms, in particular iron) satisfy the conditions laid down for the measurement of uranium-235 by interferometry, are used. The production process for such lamps is given together with the method of excitation and spectral qualities. (auth)

33460 (CEA-R-2440) DOSEUR CONTINU INFRAROUGE A FILTRE INTERFERENTIEL. DOSAGE DES MELANGES H_2O-D_2O. (Continuous Infra-red Measurement Using an Interference Filter. Analysis of H_2O-D_2O Mixtures). Maurice Ceccaldi and Paul Goujon (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). May 1964. 26p.

Original work is described which led to the construction of an apparatus for the continuous measurement of the isotopic content of H_2O-D_2O mixtures. The measurement is based on an application of the Beer-Lambert law to the ν_{OH} band of HDO (3400 cm^{-1}). The conditions of measurement are given. The apparatus is a double-beam device in which the wave length selection is obtained with an interference filter together with a modulator acting as a pass-band filter. The large-surface pneumatic detector using capacity changes has made it possible to obtain a simple optical set-up. Various results are presented. If sufficient precautions are taken to maintain the apparatus and the water at a constant temperature, it is possible to carry out measurements with a precision of ±0.002, or else to detect concentration differences of 0.001 per cent in the case of heavy waters containing more than 99.5 per cent of D_2O. (auth)

33461 (DP-879) DETERMINATION OF METALLIC IMPURITIES IN WATER BY ATOMIC ABSORPTION SPECTROMETRY. J. Allen Wheat (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). June 1964. Contract AT(07-2)-1. 15p.

The technique of atomic absorption spectrometry was studied with a single-beam grating monochromator. The limits of detection of several metals were extended up to 25-fold by increasing the length of the absorbing source, multiple-passing the analytical beam, using fuel-rich flames, varying fuel gases, and/or pumping sample solutions into the flame. The determination of down to 20 to 500 ppb of Fe, Cr, Ni, Co, Mn, and Cu in water was achieved. The coefficient of variation ranged from 4% at 10 to 100 times the limit of detection to 15% at 2 times the limit of detection. (auth)

33462 (DP-883) DETERMINATION OF URANIUM ISOTOPES IN IRRADIATED THORIUM. Robert S. Ondrejcin (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). June 1964. Contract AT(07-2)-1. 16p.

Uranium isotopes in irradiated thorium were determined by alpha pulse height analysis coupled with mass analysis. ^{233}Pa (^{233}U parent) was determined by gamma spectrometry. The precision of a single determination of ^{232}U in ^{233}U product was ±5% at the 95% confidence limit. The analysis of ^{232}U in ^{233}U product was confirmed by a method that combined low geometry alpha counting, mass analysis, and coulometry. (auth)

33463 (JEN-139-DQ/I-43) DETERMINACIÓN ESPECTROFOTOMÉTRICA DE URANIO CON ARSENAZO, PREVIA EXTRACCIÓN Y DESARROLLO DEL COLOR EN MEDIO ORGÁNICO. (Spectrophotometric Determination of Uranium with Arsenazo Previous Liquid-Liquid Extraction and Color Development in Organic Medium). F. Palomares Delgado, J. Vera Palomino, and J. C. Petrement Eguiluz (Spain. Junta de Energía Nuclear, Madrid). 1964. 39p.

The determination of uranium with Arsenazo is hindered by a great number of cations which form stable complexes and may give rise to serious interferences. By studying the optimum conditions of uranium extraction by means of tributylphosphate solutions dissolved in methylisobutylketone, under conditions for previous masking of the interfering cations, an organic extract was obtained containing all the uranium together with small amounts of iron. The possible interference derived from the latter element is avoided by reduction with hydroxylammonium chloride followed by complex formation of the Fe(II)-o-phenanthroline compound in alcoholic medium. The determination of uranium is carried out by taking an aliquot of the organic extract and developing the color in alcoholic medium. The relative stabilities of the complexes involved by the o-phenanthroline and Arsenazo reactions with the cations Fe^{2+}, Fe^{3+}, and UO_2^{2+} were studied under these conditions. (auth)

33464 (NASA-CR-52997) THE USE OF HIGH-SPEED, COMPUTER-COUPLED, AUTOMATIC SYSTEMS FOR NONDESTRUCTIVE MEDICAL AND BIOLOGIC NUCLEAR ACTIVATION ANALYSES. Richard E. Wainerdi, Lloyd E. Fite, and Edgar L. Steele (Texas. Agricultural and Mechanical Coll., College Station). [1963]. 48p.

Nuclear activation analysis is a procedure for performing qualitative and quantitative analyses by means of measuring and interpreting the results of induced nuclear transmutations. Two principal methods for measuring the activity produced by nuclear transmutation are radiochemical separations followed by simple counters, and instrumental gamma ray spectrometry. An automated, instrumental activation-analysis system is described which has been applied to several biological problems. Results are discussed for applications in the determination of Ag in rat brain tissue; the determination of Se in urine and blood; the determination of Te in blood, urine, and water; and the determination of Dy in forage, feces, and rumen digesta. (C.H.)

33465 (USNRDL-TR-756) SIMULTANEOUS DETERMINATION OF Ce^{141} AND Ce^{144} IN FISSION PRODUCT MIXTURES. M. G. Lai and H. Goya (Naval Radiological Defense Lab., San Francisco). May 27, 1964. Contract AT (49-5)-2084. 22p.

A method was developed to determine the isotopic ratio and the disintegration rates of ^{141}Ce and ^{144}Ce in the presence of each other, by gamma pulse-height analysis. The method was based on the relationship between the composition of the mixture and the integrated peak ratio of gamma and x-ray peaks. The effects of various counting conditions were examined. The usefulness of the method was exemplified by application to the simultaneous determination of ^{141}Ce and ^{144}Ce in fission product mixtures. (auth)

33466 (AEC-tr-6399(p.43-50)) MEASUREMENT OF THE HUMIDITY OF FRIABLE MATERIALS BY A NEUTRON METHOD. L. G. Belykh, Yu. P. Betin, B. I. Verkhovskiĭ, and F. A. Kurmaev. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 37-43(1962).

Slowing-down of fast neutrons is an attractive method for the automatic regulation of the humidity of friable materials such as ores, concentrates, etc. A neutron moisture meter is described which allows the measurement of the absolute water content of samples. The errors of the meter are considered. The measurement errors of the meter did not exceed 0.3% absolute moisture. (D.L.C.)

33467 (AEC-tr-6399(p.51-60)) METHOD OF CONTINUOUS CONTROL OF THE CONTENT OF MINERAL IMPURITIES IN COAL, USING NUCLEAR RADIATION. A. Z. Kulishenko and A. S. Kharitonov. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren, Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 44-51(1962).

A method for the direct determination of ash content in coal and coke is described which uses the absorption of bremsstrahlung from ^{35}S and ^{90}Sr. The performance of the ash meter is described. (D.L.C.)

33468 (AEC-tr-6399(p.61-71)) GAMMA-ABSORPTION METHOD FOR THE CONTROL OF LEAD CONTENT. G. L. Belina and V. A. Sotnikov. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 52-60(1962).

For automatic control of lead content in ores, concentrates, etc., a gamma-absorption method was developed which does not require the measurement of the surface density. The method is based on the use of soft and hard gamma rays, and ^{75}Se and ^{60}Co are used respectively as the sources of these rays. A laboratory installation for the rapid determination of lead is described, and its calibration and measurement errors are discussed. (D.L.C.)

33469 (AEC-tr-6399(p.72-82)) CONCERNING THE DETERMINATION OF THE COMPOSITION OF TWO AND THREE-COMPONENT MIXTURES BY THE SCATTERING OF BETA RAYS. D. Abdullaev and E. M. Lobanov. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 61-8(1962).

An investigation was made of the geometrical factor in the analysis of two- and three-component systems by beta ray scattering. The angle dependence of the scattering was determined for several scatterers and compared with theory. It is concluded that beta ray scattering can be used for a comparative rapid analysis of these systems with an error of ±2 to 3%. (D.L.C.)

33470 (AEC-tr-6399(p.83-91)) MEASUREMENT OF HUMIDITY OF FRIABLE BODIES WHICH CONTAIN NO HYDROCARBONS BY THE NEUTRON SLOWING-DOWN METHOD. A. K. Val'ter, M. L. Gol'din, and A. P. Krivchikov. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren, Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 69-75(1962).

An investigation of the neutron slowing-down method was conducted using dry and moist molding sand. Three different measurement methods were used and compared. The results were used to produce an electronic circuit for registering the slow neutron flux and an experimental model of a neutron moisture-content meter for friable bodies. (D.L.C.)

33471 (AEC-tr-6399(p.92-7)) METHOD OF ANALYSIS OF TERNARY MIXTURES IN IONIZATION GAS ANALYZERS. I. P. Sklyarenko, M. D. Krivitskii, and F. E. Krigman. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 76-80(1962).

The relationship between the ionization current and the nature of the gas is discussed for ionization by alpha and beta rays. It is shown that analysis of ternary mixtures with only one measuring chamber is possible if the radiation source location and the working volume of the chamber are changed during measurement. This method was studied in detail using CH_4-CO_2-air mixtures. It is further shown that this method is practicable only with alpha sources. (D.L.C.)

33472 (AEC-tr-6399(p.98-114)) RADIOACTIVE METHOD AND INSTRUMENT FOR THE ANALYSIS OF SULFUR IN LIQUID OIL PRODUCTS. Yu. G. Khachaturov. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 81-94(1962).

A direct method for the determination of sulfur in liquid hydrocarbons is given which uses absorption of soft x rays from ^{55}Fe. The principles of the method are outlined, and the design of the instrument for carrying out the method is discussed. The construction, operation, specifications, and applications of the instrument are described in detail. (D.L.C.)

33473 (AEC-tr-6399(p.115-23)) RADIOACTIVE LIQUID ANALYZER. A. M. Drobiz, R. N. Kruglov, and N. G. Mityukov. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 95-101(1962).

The liquid analyzer RAZh-1 uses absorption of beta particles from $^{90}Sr-^{90}Y$ to analyze binary liquids. The principles of the method are outlined, and the instrument is described in detail. (D.L.C.)

33474 (FTD-TT-63-814) ANALYSIS OF HIGH-MELTING COMPOUNDS. G. V. Samsonovym, A. T. Pilpenko, et al. Translation from p.7-256 of "Analiz Tugoplavkikh Soyedineniy," (a publication of the Scientific Publishing House on Ferrous and Nonferrous Metallurgy, Moscow, 1962). 325p.

This book presents the results of long-term investigations on the chemical properties and the methods for analysis of metallic and nonmetallic refractory materials. These materials include carbides, nitrides, borides, silicides, sulfides, etc. (D.L.C.)

33475 DETERMINATION OF ACTIVE HYDROGEN BY NUCLEAR MAGNETIC RESONANCE SPECTROMETRY. Paul J. Paulsen and W. D. Cooke (Cornell Univ., Ithaca, N. Y.). Anal. Chem., 36: 1721-3(Aug. 1964).

A proposed method for the quantitative determination of active hydrogen is based on the exchange reaction of the group with heavy water and the determination of the exchanging protons by NMR spectrometry. The proposed method is nondestructive, more precise than conventional methods, and can be applied to less reactive groups such as acetylenic hydrogen and CH_3CO-groups. Completeness of the exchange reaction is not usually required for the quantitative determination of the active hydrogen. (auth)

33476 ELECTRON DRIFT-VELOCITY DETECTOR FOR GAS CHROMATOGRAPHY. V. N. Smith and J. F. Fidiam (Shell Development Co., Emeryville, Calif.). Anal. Chem., 36: 1739-44(Aug. 1964).

The effect of trace impurities on the drift-velocity of electrons in pure argon was exploited for the detection of trace concentrations of permanent gases in gas chromatography. The detector is a small-volume, parallel-plate ionization chamber in which a tritium source is used to ionize the argon in a region near one electrode. Negative voltage pulses of short duration are applied to the electrode to drive electrons from the ionized region toward the opposite electrode. The pulse duration is selected so that not all electrons are collected in pure argon carrier gas. Trace concentrations of components eluted from a chromatographic column and passing through the detector increase the electron drift-velocity and thus increase the electron current to the collector electrode. Sensitivity was measured for a number of permanent gases and a few light hydrocarbons. The lower detectable limit for nitrogen is about 10^{-10} g/sec. (auth)

33477 DETERMINATION OF CARBON IN SODIUM BY ISOTOPE DILUTION MASS SPECTROMETRY. Ken Y. Eng, Raymond A. Meyer, and Carleton D. Bingham (Atomics International, Canoga Park, Calif.). Anal. Chem., 36: 1832-4(Aug. 1964).

A method utilizing isotope dilution mass spectrometry was developed for the determination of carbon in sodium. The details of the method are described for the determination of elemental carbon employing Van Slyke oxidation, although, by choice of spike material, other forms of carbon may be determined. Accuracy and precision in the ranges 50 ± 10 μg to 150 ± 25 μg of carbon were demonstrated. The determination is not affected by loss of generated carbon dioxide or by contamination from any source except carbon. (auth)

33478 INTRASCINTILLATION VIAL REACTION TUBE. G. G. Slater, Edward Geller, and Arthur Yuwiler (Veterans Administration Center, Los Angeles and U.C.L.A. Center for Health Sciences, Los Angeles). Anal. Chem., 36: 1888 (Aug. 1964).

Design of a simple, inexpensive, and versatile apparatus for the rapid collection of evolved $^{14}CO_2$ by liquid scintillation is described. The apparatus consists of a three-holed, flanged-top incubation chamber made from 16 mm borosilicate glass tubing that fits into a standard 28×57 mm scintillation vial containing Hyamine and the apparatus is sealed with a rubber sleeve stopper. It has the advantage of eliminating liquid transfer before scintillation counting. It provides a short gas path to minimize diffusion time and requires relatively little space so that a large number can be conveniently used in one experiment. (P.C.H.)

33479 MASS-SPECTROMETRIC DETERMINATION OF MICROQUANTITIES OF BORON IN SOME MATERIALS. L. Ya. Memelova, G. M. Kukavadze, and B. V. Ershler. At. Energ. (USSR), 16: 423-6(May 1964). (In Russian)

For the determination of boron, the method of isotopic dilution was used. The isotopic composition of boron was determined using a single filament thermionic source with a tungsten or tantalum wire on which borax was deposited. Because of surface ionization in the source, ions of $Na_2BO_2^+$ with masses 88 and 89 were evaporated, containing the isotopes ^{10}B and ^{11}B respectively. The boron with almost pure ^{10}B served as a label. The surplus of alkali obtained on solution of the investigated material was separated by electrolysis with a mercury cathode. The silicic acid remain-

ing in solution after coagulation was separated by centrifugation. After condensing the liquid to a few drops, it was deposited on the filament of the thermionic source. Boron, contained in the samples in quantities up to several units in 10^{-7}%, was analyzed. Apparently this method may be used for any materials soluble in alkali and insoluble in water. (tr-auth)

33480 ANALYTICAL METHODS BASED ON THE REFLECTION AND ABSORPTION OF RADIOACTIVE RADIATION. II. THE RADIOMETRIC DETERMINATION OF ASH IN VEGETABLE DRUGS. J. Jombik, J. Majer, and P. Schiller (Univ. of Comenius, Bratislava). Cesk. Farm., 13: 241-5(June 1964).

A new method based on the reflection of beta radiation is described. Intensity of such a radiation increases with the atomic number, and with the number of radiating atoms, that is with the concentration of the analyzed substance. The atomic number of elements forming the ash is always higher than the atomic number of the atoms of the organic molecule. Equipment used for the analysis is described. ^{90}Sr provides the source of radiation. Factors causing differences between the result of gravimetric methods and the method suggested are discussed. The method is quick, and the sample analyzed remains undamaged. Time required is 3-5 minutes, accuracy ±0.70%. (OTS)

33481 VOLUMETRIC DETERMINATION OF GADOLINIUM WITH SODIUM PHOSPHATE IN PRESENCE OF BROMOCRESOL PURPLE. Wiktor Wawrzyczek and Andrzej Benedict. Chem. Anal. (Warsaw), 9: 621-2(1964). (In Polish)

33482 PROGRESS IN THE ANALYTICAL CHEMISTRY OF NIOBIUM AND TANTALUM. Venceslav Patrovskii (Central Inst. of Geology, Prague). Chem. Listy, 58: 657-64(June 1964).

Methods of separations for Nb and Ta are described; extraction methods and paper and absorption column chromatography are discussed. The determination of Nb and Ta by polarography, titration methods, photometry, and methods based on spectrophotometry, radioisotopes, and neutron activation are also described. 130 references are included. (OTS)

33483 MODERN APPLICATIONS OF RADIOISOTOPES IN ANALYTICAL CHEMISTRY. J. Hoste, F. Adams, and R. Dams. Chem. Weekblad, 60: 35-40(1964).

A short review of the determination of tungsten, niobium, and tantalum by means of homogeneous precipitation is presented. Tungsten is determined in a solution of H_2O_2–HNO_3 with ^{187}W as tracer. The coprecipitation of Mo and V was studied with the tracers ^{99}Mo and ^{48}V. Niobium and tantalum can be determined in the same manner; ^{182}Ta and ^{95}Nb were used as tracers. The duration of the analysis is reduced by using a SeO_2-catalyst. The determination of antimony by means of neutron activation analysis is also discussed. (NPO)

33484 THE DETERMINATION OF RADIOACTIVE STRONTIUM IN WATER. E. L. Molt. Chem. Weekblad, 60: 245-6(1964).

The widely used HNO_3-method for radiochemical analysis of strontium in water has several disadvantages: the manipulations required are rather complicated and difficult and the method takes much time. With the described method strontium as nitrate is separated from calcium nitrate by boiling with amyl alcohol. The method has a high output, namely, more than 98%. It does not take much time, and the manipulations are rather easy. (auth)

33485 APPLICATION OF GAMMA SPECTROMETRY TO THE QUALITATIVE AND QUANTITATIVE ANALYSIS OF TRACES OF RADIOISOTOPES DISSOLVED IN WATER. Ch. A. Bizollon and R. Moret (Faculté de Medecine et de Pharmacie, Lyon). Chim. Anal. (Paris), 46: 273-85(June 1964). (In French)

A method allowing the identification and determination of traces of radioisotopes, γ emitters, present in different liquid samples is described. The counting apparatus contains a spherical 10-liter receptacle to be filled with the liquid to be analyzed and two scintillation probes connected with a 128-channel γ spectrometer. One of the probes is supplied with a NaI(Tl) crystal and the other with a plastic scintillator. With these two detectors, γ spectra stripped of all Compton distribution could be obtained even from complex sources. The device is shielded by 5 cm of lead. Measurements are made directly on liquid samples without the necessity of concentrating them or removing selectively the various radioisotopes that they contain. (tr-auth)

33486 ACTIVATION ANALYSIS OF DEUTERIUM BY $C^{12}(d,n)N^{13}$ REACTION IN A NUCLEAR REACTOR. E. Fabbri, E. Lazzarini, and V. Sangiust (Centro Studi Nucleari Enrico Fermi del Politecnico, Milan). Intern. J. Appl. Radiation Isotopes, 15: 437-9(July 1964).

Deuterium nuclei from n–d collisions in deuterated organic compounds react with ^{12}C. The 10-min ^{13}N activity produced in the reaction was found to be proportional to the deuterium content over a wide range. (auth)

33487 IN VIVO DETERMINATIONS OF LEAN BODY MASS FROM K^{40} MEASUREMENTS AND THE RELATIONSHIP OF THESE VALUES TO MOTOR APTITUDE IN PREADOLESCENT BOYS. J. E. Christian, A. H. Ismail, and W. V. Kessler (Purdue Univ., Lafayette, Ind.). Intern. J. Appl. Radiation Isotopes, 15: 441-5(July 1964).

The in vivo determination of lean body mass from measurements of ^{40}K with a 2-π liquid scintillation counter is described. Measurements were made on 81 boys, between 9 and 13 years of age, who were participating in a youth fitness program. The results, expressed in terms of lean body mass in kilograms and percentage of total body weight, were compared with 38 test items selected to measure motor aptitude. The factor—analysis technique—was utilized to identify the factors which could explain the items measuring body composition and motor aptitude. The technique described for the determination of body composition is considered applicable to studies of the effect of physical fitness states, age, different levels of nutrition, drugs, disease, and other factors on potassium levels, lean body mass, and body fat of large animals and human subjects. (auth)

33488 ON THE SELF-SHIELDING EFFECT IN THERMAL-NEUTRON ACTIVATION OF METALS. Y. Kamemoto (Japan Atomic Energy Research Inst., Tokyo). Intern. J. Appl. Radiation Isotopes, 15: 447-8 (July 1964).

The self-shielding effects of gold, silver, copper, cobalt, indium, gallium, antimony, chromium, selenium, and tin against thermal neutrons were investigated. Relative specific activities of the irradiated samples were plotted against E, the product of weight and absolute neutron absorption cross section divided by atomic weight. For a self-shielding effect of approximately 10%, E was found to equal about 0.03. (M.C.G.)

33489 CHANNEL RATIO IN THE DETERMINATION OF TWO GAMMA-EMITTING RADIOISOTOPES. Richard

P. Spencer and Burton Seife (Yale Univ., New Haven). J. Nucl. Med., 5: 562-4(July 1964).

Calculation of the channel ratio, when two gamma-emitting isotopes are present, can be used to determine the constants in the equations relating channel counts to quantity of radioactivity, the amount of each radioisotope in a mixed sample, the ratio of the two radioisotopes, and the fraction of either isotope in a mixture. (auth)

33490 INSTRUMENT FOR RADIOCHROMATOGRAM READING. E. Musyck (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). J. Sci. Instr., 41: 445-8(July 1964).

The instrument for β-ray radiochromatogram reading consists of a mechanical device to drive the chromatogram paper, a detection system with a proportional counter, an amplifier, and a discriminator. The electronic equipment was designed to permit a wide range of counting rates. A theoretical study of the response of the whole system in the case of a detection rate changing with time according to a Gaussian law is presented. In general this study can be applied to various fields: gas chromatography, sliding channel spectrometry, etc. (auth)

33491 DETERMINATION OF SMALL GAS CONTENT IN METALS. F. Sperner and K.-H. Koch (W. C. Heraeus GmbH, Hanau, Ger.). Metall, 18: 701-4(July 1964). (In German)

A series of analytical methods is available for the determination of low gas concentrations in metals. The vacuum fission method is of the greatest significance as it has the advantages of high detection sensitivity, wide range of applicability, and simple manipulation. Its high sensitivity was obtained when a gas chromatographic column in combination with an argon ionization detector working under precautions was used as an analytical unit. Various metals degassed by electron beam fusion or zone fusion were analyzed in a vacuum hot extraction installation of this conception. Gas concentrations below 1 ppm could be detected reliably and reproducibly. (tr-auth)

33492 SHORT-LIVED NUCLIDES FORMED BY NEUTRON ACTIVATION. Minoru Okada (Government Chemical Industrial Research Inst., Tokyo). Nucleonics, 22: 110-11 (Aug. 1964).

In neutron activation analysis various types of neutron reactions are likely to occur simultaneously. To analyze an element in a sample it is necessary to consider all of these interfering reactions. A table is presented that gives the original element, the type of neutron reaction, the nuclide formed, half life, gamma energies, and other decay particles present. (C.E.S.)

33493 PHOSPHOLIPID PATTERNS IN LIVERS ACCUMULATING FAT. Fred Snyder and Walter Lewis (Oak Ridge Inst. of Nuclear Studies, Tenn.). Proc. Soc. Exptl. Biol. Med., 116: 459-62(1964).

Fatty livers produced by cerium injection showed 3 main alterations in the liver phospholipid pattern separated on silicic acid columns. These included the appearance of a secondary peak in the polyglycerol phosphatide fraction (eluted with chloroform : methanol), a small but consistent increase in the phosphatidic acid-polyglycerol phosphatide fraction, and a decrease in the lecithin fraction for all fatty livers measured in this study. (auth)

33494 NEUTRON ACTIVATION ANALYSIS OF TRACES OF SODIUM IN QUARTZ. L. Rybach (Eidgenossische Technische Hochschule, Zurich). Radiochim. Acta, 2: 138-40(Mar. 1964).

A nondestructive method for sodium-trace determination is described. Sixteen quartz samples widely distributed over the Swiss Alps were investigated. The sodium contents were measured after irradiation with 3.6×10^{12} slow n/cm^2, sec by γ spectrometry. Concentrations of 0.15 to 24 ppm (sodium quantities of 0.03 to 5 μg in this case) were found. The considerable spread of results demonstrates the different conditions of formation of the quartz crystals. (auth)

33495 DETERMINATION OF TRACE PROTACTINIUM-231. Hans-Ludwig Scherff and Guenter Herrmann (Universität, Mainz). Radiochim. Acta, 2: 141-6(Mar. 1964). (In German)

A procedure is given in which 10^{-6} ppm ^{231}Pa in 10 g samples can be determined. After leaching of the samples with HF/$HClO_4$ or HF/H_2SO_4 and evaporation of the HF, the Pa is coprecipitated with hydroxides by NaOH. The precipitate is dissolved in a mixture of 6 M HCl and 0.5–3 M HF; Fe, Nb, and Ta are extracted by diisobutylcarbinol. Fluoride is then complexed by Al^{3+}, and Pa extracted by the same solvent. The γ or α counting rate of the extract gives the ^{231}Pa contents. (auth)

33496 A NEW OXIDIMETRIC REAGENT: POTASSIUM DICHROMATE IN A STRONG PHOSPHORIC ACID MEDIUM. IV. TITRIMETRIC DETERMINATION OF URANIUM$^{(IV)}$ ALONE AND IN MIXTURE WITH IRON$^{(II)}$, MANGANESE$^{(II)}$, CERIUM$^{(III)}$ OR VANADIUM$^{(IV)}$. G. Gopala Rao and P. Kanta Rao (Andhra Univ., Waltair, India). Talanta, 11: 1031-40(July 1964).

The potentiometric titration of uranium(IV) is possible at room temperature with potassium dichromate at all concentrations of phosphoric acid ranging from 3 to 12M. An inert atmosphere is unnecessary. The potential break at the end-point is about 70–90 mv/0.4 ml of 0.1N potassium dichromate in the range 3 to 9M of phosphoric acid, 140 mv in 10.5M phosphoric acid and 180 mv in 12M phosphoric acid. Iron(II) and uranium(IV) can be determined in the same solution if the concentration of phosphoric acid is maintained above 11.5M at the iron(II) end-point. Under similar conditions a differential potentiometric titration of uranium(IV) and vanadium(IV) is possible. Uranium(IV) and manganese(II) can be determined in the same solution if the concentration of phosphoric acid is maintained between 3 and 9M at the uranium(IV) end-point, then increased so that it is 12M at the manganese(II) end-point. Under similar conditions the differential potentiometric titration of uranium(IV) and cerium(II) is possible. (auth)

33497 RECENT DEVELOPMENTS IN THE RING OVEN TECHNIQUE. Herbert Weisz (Universität, Freiburg i. B.). Talanta, 11: 1041-60(July 1964).

A review of recent developments in the ring oven technique is presented. 74 references are included. (auth)

33498 ANALYTICAL USES OF BROMANILIC ACID. R. B. Hahn, P. T. Joseph, and G. G. Salciccioli (Wayne State Univ., Detroit). Talanta, 11: 1073-80(July 1964).

Bromanilic acid (2,5-dibromo-3,6-dihydroxyquinone) precipitates barium, calcium, and strontium quantitatively from weakly acid solution, and forms a colored complex with zirconyl ions in perchloric acid solution. The complex exhibits maximum absorbance at a wavelength of 335 mμ. Beer's law is obeyed in the range from 0.0 to 3.5 ppm of zirconium. Optimum results are obtained in solutions 2.8M in perchloric acid. The effect of various diverse ions was investigated. Hafnium gives results identical with zirconium. Other interfering ions are Fe(III), Th(IV), UO_2(II),

Ti(IV), phosphate, oxalate, fluoride, and sulfate. Errors caused by varying amounts of these ions were determined. A procedure for the determination of zirconium is given. Bromanilic acid is a more sensitive reagent than chloranilic acid for the determination of zirconium, and can be used over a slightly greater range. (auth)

33499 PAPER-CHROMATOGRAPHIC SEPARATIONS OF FRAGMENTS FROM γ-IRRADIATED OVALBUMIN. Charles A. Leone (Univ. of Kansas, Lawrence). Trans. Kansas Acad. Sci., 66: 539-44(1964).

The solvent, 2,6-lutidine : 2,4,6-collidine : diethylamine : water in the proportions 100 : 100 : 3 : 100, was used for making one-dimensional paper chromatographic separations of fragments produced in lyophilized ovalbumin that had been γ-irradiated with 13×10^6 rads. Three peptide fragments were detected in protein that had been irradiated in vacuo; 8 fragments were found in protein that was irradiated in air. The fragments had an average molecular weight of 350. (auth)

33500 FLAME PHOTOMETRY DETERMINATION OF SMALL CESIUM CONTENTS IN SILICATES AFTER ENRICHMENT ON A ZIRCONIUM PHOSPHATE ION EXCHANGER. Otto Osterried (Technische Hochschule, Munich). Z. Anal. Chem., 199: 260-70(1964). (In German)

The determination of cesium in rocks by flame photometry is described. In this method cesium is first enriched on zirconium phosphate that is then dissolved in hydrofluoric acid. Interfering anions are removed from the solution by a strongly basic anion-exchanger. As little as 0.2 ppm of cesium can be determined in silicates with a sample weight of 1−2 g using dilute hydrochloric acid as solvent. Standard deviation and accuracy are probably not worse than ±10%. The method was checked by help of ^{137}Cs. Cesium was determined in some geochemical silicate samples. (P.C.H.)

33501 PREPARATION OF SULFUR DIOXIDE FOR THE MASS SPECTROMETRIC DETERMINATION OF THE SULFUR ISOTOPE RATIO $^{32}S/^{34}S$ IN NATURAL SULFUR COMPOUNDS. Werner Ricke (Zentrallaboratorium für Geochemie der Isotope, Gottingen, Ger.). Z. Anal. Chem., 199: 401-13(1964). (In German)

A method for the preparation of sulfur dioxide from sulfide and sulfate containing rocks and ores is described that permits the determination of the $^{32}S/^{34}S$ ratio with a mean error of 0.2‰. This error consists of errors involved in the SO_2 preparation, in passing the SO_2 into the mass spectrometer, and in the actual measurement. The mean error arising from isotope fractionation during the SO_2 preparation is, therefore, undoubtedly smaller than 0.2‰. (P.C.H.)

33502 ACTIVATION ANALYSIS INVESTIGATIONS ON HIGH-PURITY SILICON. W. Gebauhr and J. Martin (Siemens-Schuckertwerke AG, Erlangen, Ger.). Z. Anal. Chem., 200: 266-78(1964). (In German)

For the activation analysis of high-purity silicon the supposed impurities were divided into 3 groups corresponding to the half lives of the radionuclides belonging to the impurities. Chemoanalytical separation schemes were developed for these groups. With this technique it was possible to determine about 30 elements in small samples. The results given are in or below the ppb-level. For localization of the impurities autoradiography was used. Some of the pictures taken show, that also with very low activities, valuable results can be obtained. (P.C.H.)

33503 REPORT ON THE COMPLEXOMETRIC DETERMINATION OF ZIRCONIUM. R. Přibil and V. Veselý (Lab. for Analytical Chemistry, Czechoslovak Academy of Sciences, Prague). Z. Anal. Chem., 200: 332-7(1964). (In German)

The complexometric determination of zirconium was studied. Especially the influence of boiling time as well as of different acids was investigated. For the separation of Zr from iron and other metals the precipitation in triethanolamine solution is recommended. (auth)

33504 PHOTOMETRIC DETERMINATION OF CERIUM IN ALLOYED STEELS AND HEAT-CONDUCTING ALLOYS. H.-J. Graebner (Stahlwerke Bochum AG, Bockum, Ger.). Z. Anal. Chem., 201: 401-17(1964). (In German)

The separation of cerium from high-alloy steels and heat conducting alloys was accomplished by means of a precipitation with hydrofluoric acid in the presence of lanthanum as a trace carrier. Without further reprecipitations the purified precipitation is boiled after solution with persulphate and silver ions. After the photometric measurement Ce^{4+} is reduced to Ce^{3+} by means of sodium azide and again measured photometrically. Cr^{6+} from which small amounts are always entrained in chrome-bearing alloys and which is always measured in both cases remains hereby unconsidered. With the described analytical procedures cerium contents in the range of 0.0001 to 0.25% Ce can be determined. For a cerium content of 0.05% the standard deviation is 0.001, and for 0.25% Ce it is 0.002. Several tables demonstrate the accuracy and precision of these procedures. (auth)

33505 PAPER CHROMATOGRAPHIC SEPARATION OF THORIUM, ZIRCONIUM AND URANIUM. MICRO DETERMINATION USING β-SNADNS-6. Sachindra Kumar Datta and Sachindra Nath Saha (Victoria Coll., Cooch Behar, India). Z. Anal. Chem., 202: 332-9(1964).

The possibility of paper chromatographic separation of a number of elements (Th, U, Zr, Fe, Mg, Ni, Co, Ce, La, Y, Sm, Gd) was studied, employing solvent mixtures containing tri-n-butyl phosphate (TBP) as principal constituent. Various factors that influence the R_f values were investigated. It was found possible to separate only thorium and uranium from the other elements including the rare earths and also from one another. Only thorium and uranium move under the conditions studied, the others remain stationary on the starting line. The solvent mixture methylisobutyl ketone-isobutyl alcohol-TBP (50 : 38 : 12) shaken with 4 M HNO_3 proved to be a good mobile solvent for the separation of thorium and uranium. Thorium was also separated from monazite extract. A single chromatogenic spray (β-SNADNS-6) was used for the detection of all the elements. Thorium, uranium, and zirconium were also quantitatively estimated after chromatographic separation by EDTA titration using the same dye. (auth)

33506 FLUORESCENCE OF URANIUM IN FLUORIDE-CARBONATE MELTS. Evžen Singer and Dagmar Cífková. Z. Anal. Chem., 202: 401-7(1964). (In German)

The influences of different elements and their mixtures on the fluorescence of uranium in a melt of NaF and $NaKCO_3$ were investigated. The evaluation of the quenching effect of mixtures is difficult as the quenching efficiencies of the elements vary within a range of about two powers of ten. The influence of platinum was found to be smaller than is generally assumed and the errors observed appear to be caused by variations in the duration and degree of heating. The results obtained were applied to the sometimes rather difficult problem of determining uranium in urine. A procedure was worked out that permits the determination of up to 10^{-6} g U/l urine without serious interferences. (auth)

33507 STUDIES ON THE REACTION BETWEEN MERCURY(II) AND CDTA. ESTIMATION OF METAL IONS AND ANALYSIS OF CATION MIXTURES. H. Khalifa (Eötvös Univ., Budapest). Z. Anal. Chem., 203: 161-8 (1964).

Studies were made on the reaction between mercury and cyclohexane-diaminotetraacetic acid (CDTA) in a variety of hexamethylene tetramine buffered solutions covering the range of pH 5-12 and its application to the determination of a variety of cations by back titrating excess CDTA amounts at different pH values. It was found that the method allows the determination of micro and milligram amounts of Hg, the alkaline, rare earth, and some of the heavy metals with high accuracy and precision under normal conditions without the interference of oxygen. Further, by its aid binary mixtures of the alkaline-earth metals with a variety of metal ions can be analyzed at a selective pH. The procedures given are simple, rapid, and extremely reliable. (P.C.H.)

33508 CHELATE-FORMING EXCHANGER RESINS. V. Zr(IV) SPECIFIC CHELATE EXCHANGER ON PYROCATECHOL-O,O-DIACETIC ACID BASE. E. Blasius and G. Kynast (Technische Universität, Berlin). Z. Anal. Chem., 203: 321-32(1964). (In German)

Condensation products containing catechol-O,O-diacetic acid as chelating group are specific for zirconium. The influence of the conditions of the preparation on the quality of the resin, especially the rate of cross-linking, was investigated. The effective capacity of the most favorable product is satisfactory; it depends on the hydrogen ion concentration (2.1 mmole Zr/g resin at pH 4.7). A series of batch absorption tests were run in order to estimate the absorption of several cations. Under similar conditions the following ions can be separated easily from Zr(IV): Mg^{2+}, Cu^{2+}, Ni^{2+}, Al^{3+}, Y^{3+}, La^{3+}, TiO^{2+}, UO_2^{2+}, Fe^{3+}. Furthermore, a separation of the radionuclides ^{95}Zr and ^{95}Nb was investigated. Since the resin is highly selective, the column operation requires only little time. It may be adapted, very probably, also to other separation problems. (auth)

33509 DETERMINATION OF COPPER, MERCURY, AND SILVER IN PURE URANIUM COMPOUNDS. Josef Marecek and Evzen Singer. Z. Anal. Chem., 203: 336-9 (1964). (In German)

A method for the determination of copper, mercury, and silver in pure uranium compounds is described. It is based on the selective extraction of these elements by dithizone. Concentrations as low as 1 ppm of Hg and Ag and 0.5 ppm of Cu may be determined. Only Pd(II) and Au(III) and higher concentration of chloride interfere. One analysis requires about 1 hour. Because of its excellent selectivity and sensitivity the method may be used for analyses of other materials, too. (auth)

33510 TITRATION OF RARE EARTHS (e.g., GADOLINIUM) WITH SODIUM TUNGSTATE SOLUTION AND A MIXTURE OF BROMCRESOL PURPLE AND METHYL RED AS ADSORPTION INDICATOR. Wiktor Wawrzyczek and Wieslaw Wisniewski. Z. Anal. Chem., 203: 339-44 (1964). (In German)

Gadolinium can be rapidly determined by titration with sodium tungstate solution using an indicator either bromocresol purple or a mixture of bromocresol green and methyl red. Errors are about 1% when bromocresol purple is employed and about 0.5% in case of the mixed indicator. The titration has to be performed in hot solution (previously heated almost to the boiling point). Heavy metals and other rare earths may be determined by a similar procedure. The separate determination of gadolinium in the presence of these elements is impossible. (auth)

33511 A SIMPLE APPARATUS FOR RAPID DETERMINATION OF HYDROGEN CONTENT IN TITANIUM AND ZIRCONIUM AND THEIR ALLOYS. Joseph Fischer and Edith Leicht (Johann Wolfgang Goethe-Universität, Frankfurt am Main and Metallgesellschaft AG, Frankfurt am Main). Z. Metallk., 55: 328-30(June 1964). (In German)

A simple apparatus is described for the fast determination of hydrogen in high melting metals and alloys. Induction heating is used and the hydrogen is measured in the rough vacuum of a mercury diffusion pump. Approximately 2 μg hydrogen can be determined with ±5% accuracy. Ten analyses can be made per day per man. (auth)

33512 PHOTOMETRIC DETERMINATION OF ZIRCONIUM IN MAGNESIUM AND ALUMINUM ALLOYS USING QUERCETIN. L. Ya. Polyak and I. S. Bashkirova. Zh. Analit. Khim., 19: 842-6(1964). (In Russian)

A direct photometric method was developed for the determination of zirconium in magnesium and aluminum alloys using quercetin. It permits the determination of 0.002–1.0% of Zr and more on the background of all the constituents of magnesium and aluminum alloys. (P.C.H.)

33513 DETERMINATION OF SMALL AMOUNTS OF SULFUR IN BERYLLIUM, ZIRCONIUM, NIOBIUM AND THEIR OXIDES. A. F. Fioletova. Zh. Analit. Khim., 19: 868-70(1964). (In Russian)

Investigations showed that from 1×10^{-7} to 1×10^{-5} g of S can be determined by a luminescent method using quinine sulfate. The optimum conditions for sulfur determination are at 1×10^{-6}–7.5×10^{-6} g of S in 10 ml of the solution. The results obtained are quite reliable. (auth)

33514 SIMULTANEOUS AMPEROMETRIC DETERMINATION OF ZIRCONIUM AND SULFUR IN ORGANIC COMPOUNDS. E. A. Terenteva and M. V. Bernatskaya (Inst. of Organic Compounds, Moscow). Zh. Analit. Khim., 19: 876-80(1964). (In Russian)

A method for the simultaneous determination of zirconium and sulfur in organic substances was developed. Decomposition of the sample is carried out by fusion with sodium carbonate. Zirconium is determined in the solution of the melt by the direct amperometric titration on a rotating platinum microanode by the current of EDTA oxidation at the potential of +0.9 v using HCl at pH 3 as a supporting electrolyte. Sulfur is determined as sulfate in the second aliquot of the solution. Zirconium is bound beforehand by the exact equivalent amount of EDTA. Sulfate ions are precipitated with barium of which the excess is titrated amperometrically with EDTA. (auth)

33515 SPECTROGRAPHIC AND NEWER METHODS OF IMPURITY ANALYSIS IN REFRACTORY METHODS. A. H. Gillieson (Dept. of Mines and Technical Surveys, Ottawa). p.381-93 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Existing or potential methods for determination of interstitial and substitutional impurity elements in trace amounts in the refractory metals molybdenum, niobium, tantalum, and tungsten are reviewed, with particular reference to the physico-chemical methods: vacuum-fusion, emission spectrography, mass spectrometry, and activation analysis. For the interstitial impurities hydrogen, oxygen, nitrogen, and carbon, vacuum fusion was adequate for hydrogen and oxygen, and nitrogen and carbon were determined satis-

factorily down to about 10 ppm by the classical methods of Kjeldahl distillation and of combustion, respectively. Research into the application of solid-source mass spectrometry for the determination of all the interstitial impurities and of fast neutron activation analysis for the determination of oxygen is recommended. The determination of the general substitutional impurities is being adequately performed by d-c arc methods, employing controlled atmospheres or stabilization of the arc by the Stallwood air-jet. Spectrophotometric methods of high sensitivity and precision were developed for a few elemental impurities. Applications of the electron probe x-ray microanalyzer, activation analysis, and in particular solid-source mass spectrometry appeared worthy of investigation. (auth)

33516 THE ANALYSIS OF REFRACTORY METALS FOR IMPURITIES. R. Orsage. p.395-8 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

The methods considered most advisable for routine determination of oxygen, hydrogen, nitrogen, carbon, and iron in refractory metals are presented. (M.C.G.)

33517 INVESTIGATIONS ON THE TRACE ELEMENT CONTENT OF LEUCOCYTES BY MEANS OF NEUTRON ACTIVATION ANALYSIS. H. Frischauf, H. Altmann, and G. Stehlik. p.234-9 of "Proceedings of the 9th Congress of the European Society of Haematology, Lisbon, Portugal, Aug. 26-31, 1963. Volume I." Basel, Verlag S. Karger AG, 1963.

Neutron activation analysis was used to investigate the content of Cu, Mn, and Zn in leukocytes from normal and leukemic persons. Analytical procedures are described. Variations were found in Cu and Mn content of normal and leukemic cells, but no essential difference was found in Zn content. Possible diagnostic applications of the findings are discussed. (C.H.)

33518 A SURVEY OF THE METHODS USED IN THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY FOR THE DETERMINATION OF RADIONUCLIDES IN URINE. S. Jackson (Atomic Energy Research Establishment, Harwell, Berks, Eng.) and N. A. Taylor. Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/16, 24p. (CONF-448-13)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

A survey was made throughout the United Kingdom Atomic Energy Authority of current practice in urine analysis for radionuclides. The elements of greatest importance in the UKAEA programs of urine analysis are plutonium, uranium, tritium, and fission products (notably strontium-90 and cesium-137). Other radionuclides dealt with are polonium-210, radium-226, protactinium-231, phosphorus-32, carbon-14, sulphur-35, americium-241, and thorium. In assessing the function and scope of urine analysis, the factors affecting the choice of a suitable analytical method are discussed. From the available data about their metabolism, an approximate urinary excretion rate is proposed for each of the above radionuclides. (C.H.)

33519 USE OF RADIOCHEMICAL ANALYSIS OF URINE TO DIAGNOSE INTERNAL RADIOACTIVE CONTAMINATION BY Po^{210}, Ag^{110} AND S^{35}. G. Furnica and N. Racoveanu (Institutul de Higiena si de Securitatea Muncii, Bucharest). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/78, 8p. (CONF-448-30). (In French)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

Results of diagnosing internal contamination with ^{210}Po, ^{110}Ag, and ^{35}S by the indirect method consisting in radiochemical analysis of urine are given. In one case of internal contamination with ^{210}Po contamination took place through direct contact between the hand and a $^{210}Po-\alpha-Be$ neutron source (activity 3.9c). Three persons were contaminated through handling the capsule containing the radioactive source. The diagnosis of internal radioactive contamination was carried out using radiochemical analysis of urine 30 days after contamination. The ^{210}Po was separated from the mineral residue of the urine on Ni by the electrochemical method. Activities of 3.6–42.0 pc ^{210}Po per liter of urine were found. The contaminated subjects were observed for a period of 20 months and no changes were noted in their state of health. Contamination with ^{110}Ag was caused through clothes and industrial equipment being splashed with a solution of the substance. The equipment showed contamination of 2.54×10^{-10} c/cm^2. The urine samples taken from four contaminated persons contained $0.93-1.58 \times 10^{-11}$ c/l. The total uptake of radioactivity was found by calculation to be $97-149 \times 10^{11}$ c. Determination of ^{110}Ag was carried out by coprecipitation of the Ag from the mineral residue of the urine solubilized with HNO_3. In the two subjects who had handled ^{35}S, the presence of ^{35}S was found in the urine 30 days later; the ^{35}S was determined by coprecipitation in the form of $BaSO_4$. The activity found was of the order of $0.38-0.40 \times 10^{-11}$ c/l urine. The uptake of activity as determined from calculation was of the order of $0.67-1.02 \times 10^{-10}$ c of ^{35}S. (auth)

Inorganic and Physical Chemistry

Refer also to abstract 33858.

33520 (AD-436582) SURVEY OF THE ELECTRONIC STRUCTURE AND SPECTRAL BEHAVIOR OF THE URANYL ION. J. B. Newman (Johns Hopkins Univ., Baltimore. Carlyle Barton Lab.). Apr. 1964. Contract AF33(615)-1051. 104p. (WR-AF-4)

The two main considerations of this report are to provide a coherent view of what is known about the uranyl ion, and to discern, if possible, the course of a fresh attack on the problem of its structure. The assumption is made that in order to interpret the uranyl spectra, the electronic structure and behavior in the fixed nuclear framework must first be known. Ways of finding this structure are presented, leading to the conclusion that, given the chemical evidence for strong covalent uranyl bonds, a molecular orbital treatment is required. By using a core approximation, a one-configuration trial solution is set up in terms of fixed configurations on immobile cores and an antisymmetrized product of molecular orbital basis functions for the valence electrons. The practicability of a machine solution of the molecular orbital problem is being studied further. (auth)

33521 (BNL-8081) THE MECHANISMS OF SOME ELECTRON TRANSFER REACTIONS IN SOLUTION. N. Sutin (Brookhaven National Lab., Upton, N. Y. and Weizmann Inst. of Science, Rehovoth, Israel). [1964]. Contract AT-30-2-GEN-16. 20p. (CONF-549-3)

From International Symposium on Oxidases and Related Oxidation-Reduction Systems, Amherst, Mass., July 1964.

Some inner-sphere and outer-sphere reactions involving metal complexes have been considered. Substitution-labile complexes react with oxygen via an inner-sphere mechanism in which the oxygen is bonded directly to the metal. Inner-sphere reactions are favored when the electronic interaction between the reactants is very small (as occurs, for example, when the electron transfer is accompanied by

a change in spin multiplicity) or when the energy required to reorganize the coordination shells of the reactants is very large. The reactions with oxygen proceed via mononuclear and binuclear complexes, in which an oxygen molecule is bonded to one and two metal ions, respectively. The reduction of oxygen to hydrogen peroxide can be brought about in the binuclear complex by the "simultaneous" transfer of electrons (or hydrogen atoms) by each of the metals to which it is bonded. For this reason binuclear intermediates may be quite common in reactions between a two-equivalent oxidizing agent and a one equivalent reducing agent, and vice versa. (auth)

33522 (CEA-2360) LE TRIFLUORURE DE CHLORE. (Chlorine Trifluoride). L. M. Vincent and J. Gillardeau (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 107p.

This monograph on chlorine trifluoride consists of data gathered from the literature and includes furthermore a certain amount of original data. This monograph groups together the physical, chemical, and physiological properties of chlorine trifluoride, as well as the preparation and analytical methods. Also included are technological information, and the safety regulations governing its use. (auth)

33523 (CNLM-5619) THE THERMAL DECOMPOSITION OF URANIUM MONOCARBIDE. P. A. Vozzella, A. D. Miller, and M. A. DeCrescente (Pratt and Whitney Aircraft Div., United Aircraft Corp., Middletown, Conn.). Apr. 1964. Contract AT(30-1)-2789. 11p. (CONF-553-8)

From American Ceramic Society 66th Annual Meeting Including Symposium on Nuclear and Space Applications, Chicago, Apr. 1964.

The vaporization of sintered UC was studied by the Langmuir evaporation technique at 2190 to 2525°K. UC was found to lose U preferentially until a congruently vaporizing composition near $UC_{1.1}$ was reached. The temperature dependence of the evaporation rate of $UC_{1.1}$ was studied, and the partial pressures (atm) of U(g) and C_3(g) were found to obey the equations $\log_{10}p(U) = 8.191 - 3.624 \times 10^4/T$ and $\log_{10}p(C_3) = 7.345 - 3.624 \times 10^4/T$. The standard heat of vaporization of $UC_{1.1}$ was calculated to be 223 kcal/gfw, in fair agreement with other values for UC. (D.L.C.)

33524 (CNLM-5620) THE THERMAL DECOMPOSITION OF URANIUM MONONITRIDE. P. A. Vozzella, A. D. Miller, and M. A. DeCrescente (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Apr. 1964. Contract AT (30-1)-2789. 13p. (CONF-553-9)

From American Ceramic Society 66th Annual Meeting, Including Symposium on Nuclear and Space Applications, Chicago, Apr. 1964.

Nitrogen pressure over UN varies from 1.5×10^{-7} to 5×10^{-5} atmospheres over the temperature range 1910 to 2265°K. Uranium nitride decomposes by the reaction $UN(s) \rightarrow U(l) + N_2(g)$ in which the U(l) activity may be lowered by solution of nitrogen. The standard heat of formation of UN at 298°K was found to be -74.5 ± 1 kcal/gfw. The condensation coefficient for nitrogen on uranium nitride is estimated to be 0.01. (auth)

33525 (HW-74663) A REVIEW OF THE REACTION OF NUCLEAR GRAPHITE WITH CARBON DIOXIDE. R. E. Woodley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 17, 1962. Contract AT(45-1)-1350. 11p.

At temperatures above 650°C, the thermal reaction of CO_2 with graphite is the only important CO_2-graphite reaction occurring in a reactor environment. A review and summary are presented of kinetic data on the thermal reaction of CSF graphite with CO_2 at temperatures up to and above 1000°K. (D.L.C.)

33526 (IA-924) THE CHEMISTRY OF TRIVALENT NEPTUNIUM, PLUTONIUM AND AMERICIUM IN HALIDE SOLUTIONS. M. Shiloh and Y. Marcus (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Apr. 1964. 26p.

The species Np(III), Pu(III), and Am(III) in concentrated halide solutions were characterized by spectrophotometry and ion exchange. Each element was found to exhibit strong absorption at a characteristic wavelength when complexed with chloride or bromide: Np at 3840 Å for the chloride and 3870 for the bromide, Pu at 3120 Å (chloride) and 3150 (bromide), and Am at 2350 Å (chloride–strong absorption by the bromide ion prevents measurement of the Am peak in bromide solutions). Only small changes due to complex formation are evident at other wavelengths. The stability of the complexes formed was calculated, and was found to increase with increasing atomic number of the actinide. The chloride complexes are more stable than the bromides. The results correlate well with those for U(III). Results of ion exchange measurements were found to be consistent with those obtained spectrophotometrically. (auth)

33527 (IFA-28-IS) POISONING WITH HYDROGEN OF PLATINUM-ACTIVE CARBON CATALYST DURING THE ISOTOPIC EXCHANGE REACTION BETWEEN HYDROGEN AND WATER. I. Ursu, D. Strugaru, O. Piringer, and M. Paladi (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). [1963]. 9p.

A study was made of the variation in time of the activity of a Pt-active carbon catalyst for isotopic exchange reaction between hydrogen and water. In the absence of the oxygen, a gradual poisoning of the catalyst was observed. Some traces of oxygen reduced the effect of the poisoning and the treatment of the poisoned catalyst in oxygen or in noble gas regenerates completely its activity. The influence of small amounts of oxygen (from 0.05% O_2 up to 1% O_2) on the catalytic activity at the different steps of the poisoning was observed. (auth)

33528 (NP-14080) TERMODINAMICHESKII RASCHET REAKTSII NATRIYA S VODOI PRIMENITEL'NO K PAROGENERATORU TIPA "NATRII-VODA." (Thermodynamic Calculation of the Reaction of Sodium and Water as Applicable to a Steam Generator of the Sodium–Water Type). N. N. Ivanovskii and F. A. Kozlov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1964. 10p.

Thermodynamic calculations for determining equilibrium constants and equilibrium concentrations were made under the assumption that the amount of water and the rate of flow into the sodium do not increase the temperature. Equilibrium constants based on published data were used for determining thermodynamic characteristics of the reactions as functions of temperature. The variations of reaction isobar potentials as functions of temperature are tabulated. The results showed that sodium oxide, sodium hydride, and hydrogen are the principal products. The influence of equilibrium products on steam generator efficiency and a possible method for eliminating the products from a heat exchanger are analyzed. (R.V.J.)

33529 (ORNL-3334(Pt.II)) PRODUCTION OF TRITIUM BY CONTAINED NUCLEAR EXPLOSIONS IN SALT. II. LABORATORY STUDIES OF THE REDUCTION OF ALKALINE EARTH SULFATES BY HYDROGEN. W. D. Bond (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 31p.

The results of this investigation show that tritium produced by a contained nuclear explosion in bedded salt will be mixed with environmental water due to the oxidation-reduction reaction between alkaline earth sulfate impurities and the tritium. The reduction of alkaline earth sulfates with hydrogen occurs in the range of 700 to 900°C at readily measurable rates. Most of the work being reported was performed with magnesium and calcium sulfates, with only a few experiments being performed with strontium and barium sulfates. Dissolving $CaSO_4$ in molten salt did not lower the temperature for the onset of the reduction nor did it increase its rate. In the presence of excess hydrogen, the solid reduction product of $MgSO_4$ is MgO, whereas with calcium, strontium, or barium sulfates it is mainly the metal sulfide containing a few percent oxide. The experimentally observed reduction products qualitatively agreed with those predicted by thermodynamic calculations. Sulfite was shown to be an intermediate in the reductions. A general mechanism is proposed for the high-temperature reduction of sulfates. The proposed mechanism involves reduction of the sulfate to sulfite, with subsequent thermal decomposition of the sulfite. The final products are determined by the reactions among the sulfite decomposition products and by reactions of the reducing gas with the sulfite decomposition products. The solid reduction product and the gaseous products can be predicted from equilibrium data on the thermal decomposition of the sulfite. In developing the mechanism, several possible reactions among the sulfite decomposition products and the reaction of hydrogen with SO_2 were experimentally investigated. (auth)

33530 (ORNL-TM-829) THERMODYNAMIC CALCULATIONS RELATING TO CHLORIDE VOLATILITY PROCESSING OF NUCLEAR FUELS. I. THE GAS-PHASE REDUCTION OF URANIUM TETRACHLORIDE TO THE TRICHLORIDE WITH CARBON MONOXIDE. T. A. Gens and G. J. Atta (Oak Ridge National Lab., Tenn.). Apr. 22, 1964. Contract [W-7405-eng-26]. 27p.

The equilibrium yields of solid uranium trichloride from the reduction of gaseous uranium tetrachloride were calculated from free energy data (obtained from the literature) as a function of temperature, pressure, and the amounts of carbon monoxide and inert gases present. The calculated yields were too small for practical use under all conditions considered at temperatures down to 500°K, where the vapor pressure of uranium tetrachloride is less than 10^{-6} mm Hg. Therefore, the reduction of gaseous uranium tetrachloride with carbon monoxide to produce solid uranium trichloride in useful amounts does not appear feasible. (auth)

33531 (UCRL-11369) DERIVATION OF FUGACITY COEFFICIENTS FROM AN IMPROVED EQUATION OF STATE (thesis). Max Jacobson (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). June 1964. Contract W-7405-eng-48. 51p.

The equation of state proposed by Redlich and Kwong was improved by addition of a deviation term containing Pitzer's acentric factor and by means of a new rule for the combination of the parameters for mixtures. Only the critical temperature, pressure, and acentric factor of the components are required in a computer program furnishing compressibility factors, mean fugacity coefficients, and individual fugacity coefficients of the components. The equation is restricted so far to the gaseous state. Its accuracy for the compressibility factor is close to that of Pitzer's tables. The computation of fugacity coefficients does not entail any loss of formal precision. (auth)

33532 (UCRL-11395) NUCLEAR MAGNETIC RESONANCE STUDIES. PART I. F^{19} SPIN-SPIN COUPLING CONSTANTS. PART II. THE EFFECT OF SOLVENTS ON F^{19} SPIN-SPIN COUPLING CONSTANTS (thesis). Soon Ng (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley. Dept. of Chemistry). May 1964. Contract W-7405-eng-48. 71p.

The pattern of fluorine-fluorine coupling constants is explained on the basis of two mechanisms for nuclear spin-spin coupling: the through-bond and the through-space mechanisms. In the former, the interaction proceeds via the electronic structure in the intervening bonds. It is highly dependent on the electron-withdrawing power of the substituents on the carbon skeleton. This contribution to the coupling constant goes to zero when the sum of the electronegativities of the substituents becomes sufficiently high. The latter mechanism is operative when two fluorine atoms are sufficiently close in space for there to be appreciable overlap of their electron clouds. This through-space interaction proceeds via an electronic structure where there is no bond per se. Experimental evidence for the existence of both mechanisms is given. The effect of solvents on the coupling constants of the compounds, bromotrifluoroethylene, 1,1-dichlorotetrafluoroethane, and the rotamers of 1,1,2-trifluoro-1,2-dibromo-2-chloroethane was studied. The coupling constants are found to vary with the solvents. This implies that intermolecular interactions affect coupling constants to a degree that is not negligible. This effect of molecular interactions on fluorine coupling constants may be due to the dipolar character and polarizability of the interacting molecules. The interactions appear to be essentially of the same kind, and detailed differences arise from the nature and dipolar character of the solvent molecules. The temperature dependence of fluorine coupling constants that was reported previously may be due to this temperature dependent molecular interaction as well as population of excited vibrational states. (auth)

33533 (UJV-725/63) PREPARACE AKTIVNÍCH KYSLIČHNÍKŮ URANIČITÝCH. (Preparation of Active Uranium Dioxide). D. Jakes, J. Wolf, V. Pourová, and M. Vobořil (Československa Akademie Ved. Ustav Jaderného Výzkumu, Rez). Aug. 1963. 36p.

The preparation methods of active forms of uranium dioxide are described. The effects of ammonium polyuranate preparation and reduction processes have been studied. Temperature, concentration, and the final pH value of the precipitation influenced to a considerable extent both ammonium polyuranate and the properties of the resultant product. The precipitation rate had no larger effect as well as the drying temperature in the range up to 200°C. The reduction process with hydrogen and with a nitrogen–hydrogen mixture (1 : 3 and 1 : 1) yielded a maximum specific surface at a temperature of 700°C and at a rapid temperature increase and short delay (600°C/hour; 15–60 min). In the case of reduction with CO a higher surface decrease has been found only in the absence of water vapor. (auth)

33534 (USNRDL-TR-760) SOLUTE DISTRIBUTION IN THE $Na_2O-B_2O_3-NaCl$ SYSTEM. II. ALKALINE EARTHS AND RARE EARTHS. M. H. Rowell (Naval Radiological Defense Lab., San Francisco). June 17, 1964. Contract AT(49-2)-1167. 23p.

Radioactive tracers were used to determine the distribution of micro quantities of Ba, Sr, Nd, and Eu between the two conjugate liquid phases throughout the immiscibility region in the system $Na_2O-B_2O_3-NaCl$ at 830°C. Phase

diagram data and borate/salt distribution coefficients of the solutes were obtained. The distribution coefficients of these cations increase according to their field strengths, in agreement with the previously proposed ion-exchange mechanism for solute distribution. Distribution coefficients are extremely sensitive to phase compositions, and increase with increasing Na_2O content, until maxima are reached in the region where the borate network structure begins to break down. Large separation factors exist between the alkali metal, alkaline earth, and rare earth groups. Appreciable intragroup separation factors are also found, the Ba–Sr and Eu–Nd separation factors being about 2.7 and 1.9 respectively. Phase diagram and solute distribution data are correlated with known polyborate structures. (auth)

33535 INORGANIC ION EXCHANGERS. I. ACIDITY, HYDROLYSIS AND RESISTANCE TO ACIDS OF SOME INORGANIC ION EXCHANGERS, ESPECIALLY ZIRCONIUM PHOSPHATE. Sten Ahrland, Joergen Albertsson, Lars Johansson, Bengt Nihlgård, and Lennart Nilsson (Univ. of Lund, Sweden). Acta Chem. Scand., 18: 707-20(1964).

Procedures allowing the preparation of zirconium phosphate gels of reproducible composition, and hence reproducible sorption properties, were tried out. The products have ratios phosphate/zirconium varying from 1.05 to 1.98. For a few representative gels of various compositions, neutralization and hydrolysis curves were determined. The neutralization curves reveal the gels as moderately acid ion exchangers, with the exchange sites up to at least pH ≈ 8 entirely localized to the phosphate groups. Above pH ≈ 8, an extensive hydrolysis sets in, making the gels unsuitable for ion exchange purposes within this region. The variations between the different gels, as regards the amounts of hydrogen and phosphate ions released for a certain value of pH, are what would be expected from the variations in their composition, as determined by gravimetric analysis. (P.C.H.)

33536 ISOTOPE EFFECTS IN ELECTROLYSIS OF SOLID LITHIUM HYDRIDE. Bengt Collén (Research Inst. of National Defence, Stockholm). Acta Chem. Scand., 18: 839-40(1964).

Studies were made on the isotope effects in the electrolysis of solid lithium hydride. It was found that the length of the hydride rod decreased in agreement with calculations according to Faraday's law. The decrease in length occurred only at the anodic end. This indicates that the transport number of Li in lithium hydride is close to 1 at about 600°C. An enrichment of ^7Li was always found at the anodic end. Experimental difficulties allowed the passage of only a small quantity of electricity, resulting in a small total enrichment. Therefore only the very approximate minimum value, $\mu^+ = -0.04$, could be obtained. A small enrichment of ^7Li at the cathodic end of the hydride rod was also found. (P.C.H.)

33537 A STUDY OF THE CERIUM(IV)–OXALATE REACTION IN ACIDIC SULFATE MEDIA. Y. A. El-Tantawy and G. A. Rechnitz (Univ. of Pennsylvania, Philadelphia). Anal. Chem., 36: 1774-7(Aug. 1964).

A spectrophotometric investigation of the cerium(IV)–oxalate standardization reaction in acid sulfate media yielded evidence in support of a mechanism involving, prior to the rate determining oxidation-reduction step, the formation of a transient intermediate complex with properties that account for the observed variation in reaction rate with the nature and concentration of solvent anions. The rate of the overall reaction can be described by the expression $-\frac{d[Ce(SO_4)_3^{-2}]}{dt} = \frac{K_C K_D K_C k_3}{[H^+][HSO_4^-]}[Ce(SO_4)_3^{-2}][H_2C_2O_4]$; the various rate and equilibrium constants involved were experimentally evaluated. (auth)

33538 DETERMINATION OF HYDROGEN IN NIOBIUM. R. J. Walter and H. G. Offner (Rocketdyne, Canoga Park, Calif.). Anal. Chem., 36: 1779-81(Aug. 1964).

A fast and precise gravimetric method for the determination of hydrogen in metals is presented. The method complements the vacuum fusion method because it is useful for measuring higher hydrogen concentrations more accurately when using large samples. The method is also useful down to hydrogen contents of 22/A ppm, where A is the sample weight in grams. The analysis is based upon evolving the hydrogen at elevated temperatures, converting to water, and weighing the water. (auth)

33539 SPECTROPHOTOMETRIC DETERMINATION OF HYDROGEN CONTENT IN HEAVY WATER. Gilbert Gordon and Hideo Yamatera (Univ. of Maryland, College Park). Anal. Chem., 36: 1866-7(Aug. 1964).

A method is described for the rapid determination of the light hydrogen content of heavy water. The method is based on measurement of the intense HDO band at 16680 A due to $\nu_1 + \nu_3$ excitation. The validity of the method over a wide range of light hydrogen content is indicated and its usefulness as a routine method using commercially available spectrophotometers is shown. (P.C.H.)

33540 SPECTROPHOTOMETRIC DETERMINATION OF CERIUM WITH THENOYLTRIFLUOROACETONE AFTER CUPFERRON-CHLOROFORM EXTRACTION. Hiroshi Onishi and Yukio Toita (Japan Atomic Energy Research Inst., Tokyo). Anal. Chem., 36: 1867-9(Aug. 1964).

A method is described for the spectrophotometric determination of Ce in the presence of small amounts of Mn using thenoyltrifluoroacetone (TTA). Iron, together with several other metals, is removed by cupferron-chloroform extraction. When the TTA solution containing both Ce and Mn is shaken with aqueous solution that is 0.1 M in ammonium hydrogen fluoride and 0.2 M in HNO_3, the color due to Ce disappears completely. On the other hand, the color due to Mn remains unchanged. Therefore, Ce can be determined from the difference in absorbance. However, Mn content greater than 100 μg must be separated from Ce by a suitable method. (P.C.H.)

33541 DETERMINATION OF OXYGEN IN GALLIUM ARSENIDE BY NEUTRON ACTIVATION ANALYSIS. AN EXCHANGE OF COMMENTS. Wolfgang G. Leonhardt (Deutsche Akademie der Wissenschaften, Berlin and Zenntralinstitut für Kernforschung, Rossendorf, Ger.) and Richard F. Bailey. Anal. Chem., 36: 1879(Aug. 1964).

A previous article by Bailey and Ross (Anal. Chem., 35: 791(1963)) on the determination of oxygen in gallium arsenide by neutron activation analysis is evaluated. Triton flux and chemical etching are discussed. It was concluded that a too high value of the activation cross section previously used is probably compensated by too high ^{18}F activities. Also, a constant value of $\sigma = 0.5$ mb gives an erroneous picture of the function ^{16}O concentration vs depth and an erroneous value of the bulk oxygen concentration. A reply by R. F. Bailey is included. (P.C.H.)

33542 REDUCTION OF URANIUM TETRAFLUORIDE IN CLOSED BOMBS. I. STUDY OF THE GENERAL VARIABLES OF THE REDUCTION PROCESS. R. Anca Abati and M. López Rodríguez (Junta de Energia Nuclear, Ma-

drid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 60: 59-72(Jan. 1964). (In Spanish)

General conditions about the metallothermic reduction in small bombs (250 and 800 g of uranium) were investigated. Factors such as kind and granulometry of the magnesium used, magnesium excess and preheating temperature, which affect yields and metal quality were considered. Magnesium excess increased yields by 15% in the small bomb; concerning the preheating temperature, there is a range between which yields and metal quality do not change. All the tests were made with graphite linings. (auth)

33543 THEORETICAL INVESTIGATION OF THE ELECTRONIC ENERGY BANDS FOR ZIRCONIUM–OXYGEN CRYSTALS. PART I. METHODS OF INVESTIGATION AND DISCUSSION OF RESULTS. Stig Flodmark. Arkiv Fysik, 26: 45-64(1964).

Methods are given for calculating energy bands in crystals of zirconium with oxygen randomly distributed at certain lattice positions. The calculation procedure was programmed for the computer BESK. The calculations are performed according to the MO–LCAO method (tight binding approximation) with an effective Hamiltonian of one-electron type. All the two-center integrals involved are computed in the program and an arbitrary number of neighbors have been considered in the crystal. The atomic basis is given by the 16 Slater atomic orbitals of the N shell of zirconium. The oxygen atoms are considered as point charges only. With two zirconium atoms per unit cell the secular equations are of degree 32. These are split in the program according to the crystal symmetry. Considering 200 neighbors the program takes 25 hours of machine time for calculation of the energy bands in five directions of high symmetry in the k space, using one specified value of the oxygen concentration. Runs have been done for different oxygen concentrations and for different choices of orbital exponents. The resulting energy bands will be published separately in a forthcoming paper (part II). These results show that the crystal is an electric conductor. It is found that the 5s and parts of the 4s and 4p orbitals of free Zr are replaced by f orbitals. Although not present in free Zr the $4f\varphi$ orbitals are important for the chemical binding in the crystal. With increasing oxygen concentration the f orbitals become less important, which corresponds to successively decreasing stability and electronic conductivity of the crystal. (auth)

33544 ZIRCONIUM DIFLUORIDE. F. K. McTaggart and A. G. Turnbull (Chemical Research Labs., CSIRO, Melbourne). Australian J. Chem., 17: 727-30(July 1964).

Zirconium difluoride was prepared by the action of atomic hydrogen on thin layers of zirconium tetrafluoride, at a temperature of approximately 350°C. The compound is orthorhombic in structure. It is black, tends to take up oxygen in air, and ignites readily and burns to form zirconium dioxide. Disproportionation occurs at 800° with the formation of ZrF_4 and zirconium, and other chemical properties are similar to those of the known dihalides of Group IVA. (auth)

33545 KINETICS AND MECHANISM OF EXCHANGE REACTIONS OF OXYGEN ^{18}O WITH OXIDATION CATALYSTS. II. MOLYBDENUM AND TUNGSTEN TRIOXIDES. J. Novakova and P. Jiru (Inst. of Physics and Chemistry, Prague). Collection Czech. Chem Commun., 29: 1114-21 (May 1964).

It was established that all oxygen atoms of both molybdenum and tungsten trioxide participate equivalently in the isotopic exchange with gaseous oxygen. The reaction order with respect to oxygen pressure was estimated for both oxides to be 0.4. Activation energy is 41 kcal/mole for molybdenum trioxide and 51 kcal/mole for tungsten trioxide. (auth)

33546 THE $U_4O_9-U_3O_8$ EQUILIBRIUM AND THE DETERMINATION OF THE THERMODYNAMIC CONSTANTS OF UO_{2+x}, U_4O_9, AND U_3O_8. Alain Duquesnoy and Fernand Marion (Faculte des Sciences, Lille, France and C.S.U. d'Amiens, France). Compt. Rend., 258: 5657-9(June 8, 1964). (In French)

The equilibrium $U_4O_9(UO_{2.25}) - U_3O_8$ was studied, beginning with measurements of the isothermal variations of the electrical conductivity of oxide films as a function of the equilibrium pressure of oxygen. The results permit the calculation of the thermodynamic constants of UO_{2+x}, U_4O_9, and U_3O_8. (tr-auth)

33547 PREPARATION OF DI-CESIUM URANYL-NITRATE, $Cs_2UO_2(NO_3)_4$. R. K. Asundi and R. M. Dixit (Atomic Energy Establishment, Trombay, India). Current Sci. (India), 33: 332-3(June 5, 1964).

Chemical preparation of $Cs_2UO_2(NO_3)_4$ is described. Stoichiometric amounts of $CsNO_3$ and $UO_2(NO_3)_2-3H_2O$ were dissolved in distilled water and evaporated to dryness on water-bath. The residue on dissolution and evaporation over a sand-bath left a microcrystalline substance. The identity of the micro-crystalline powder with the crystals formed by slow evaporation at 10°C was established by fluorescence spectra. Evidence to support the existence of the compound is discussed. (P.C.H.)

33548 ANGULAR DEPENDENCE OF SPIN DENSITIES ON PROTONS OF CH_2 GROUP. R. Lenk and I. Santar (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Czech. J. Phys., 14: 469-73(1964).

The spin densities on protons of the CH_2 group of planar radicals were calculated by the valence bond method as a function of the valence angle H–C–H, using the five-electron model. (auth)

33549 CHEMICAL STRIPPING OF DIRECT CARBON REPLICAS FOR ELECTRON MICROSCOPY. A. Bassi and G. Camona (Laboratori CISE, Milan). Energia Nucl. (Milan), 11: 315-23(June 1964).

Chemical stripping baths were studied in order to allow a larger application of direct carbon replicas. This technique was developed on eleven different metals and semiconductor materials. (auth)

33550 THE KINETICS OF SOME RELATED ELECTRON-TRANSFER REACTIONS. R. J. Campion, N. Purdie, and N. Sutin (Brookhaven National Lab., Upton, N. Y.). Inorg. Chem., 3: 1091-4(Aug. 1964). (BNL-7809)

The kinetics of the oxidation of a number of substituted tris(1,10-phenanthroline) complexes of iron(II) by cobalt(III) in perchloric acid were investigated by the use of a flow technique. The results are compared with other oxidation reduction reactions involving the iron(II)-phenanthroline complexes. The oxidation of $Fe(dipy)_3^{2+}$, $Fe(dipy)_2(CN)_2$, $Fe(dipy)(CN)_4^{2-}$, $Fe(CN)_6^{4-}$, and the corresponding phenanthroline complexes by cerium(IV) in sulfuric acid was also investigated. It was found that the oxidation of the mixed-ligand complexes proceeds more rapidly than the oxidation of the complexes containing identical ligands. Other oxidation-reduction reactions studied include the oxidation of $W(CN)_8^{4-}$ and $Mo(CN)_8^{4-}$ by Ce(IV) and $IrCl_6^{2-}$, as well as the $Mo(CN)_8^{3-}-W(CN)_8^{4-}$, $Mo(CN)_8^{3-}-Fe(CN)_6^{4-}$, and $Fe(CN)_6^{3-}-W(CN)_8^{4-}$ reactions. The results are discussed in the light of the Marcus theory of electron-transfer reactions. (auth)

33551 INFRARED SPECTRA OF $(CO)_5Mn-Re(CO)_5$ AND THE CARBONYLS OF MANGANESE, TECHNETIUM, AND RHENIUM; ASSIGNMENT OF C≡O AND M=C↕ STRETCHING ABSORPTIONS. N. Flitcroft, D. K. Huggins, and H. D. Kaesz (Univ. of California, Los Angeles). Inorg. Chem., 3: 1123-30(Aug. 1964).

The infrared spectrum of $(CO)_5Mn-Re(CO)_5$ in the region 3000 to 290 cm^{-1} is reported and compared to the spectra of the parent carbonyls, $Mn_2(CO)_{10}$ and $Re_2(CO)_{10}$. An assignment of the carbonyl and metal-carbon stretching bands for these compounds is proposed. The spectrum of $Tc_2(CO)_{10}$ in the region 800-290 cm^{-1} is reported for the first time. (auth)

33552 REACTIONS OF $A^{III}_2 B^{VI}_3$ TYPE CERIUM AND GALLIUM SELENIDES. G. Kh. Efendiev, Z. Sh. Karaev, and I. O. Hasibov (Inst. of Chemistry, Academy of Sciences, Azerbaidzhan SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1103-6(June 1964). (In Russian)

Thermal, microhardness, and x-ray analyses of Ce_2Se_3-Ga_2Se_3 revealed the presence of dark red $CeGaSe_3$ that crystallizes into hexagonal syngony and up to the melting point remains thermally stable in a $\approx 10^{-3}$ mm Hg vacuum. It is easily soluble in HCl and HNO_3 (separating elementary selenium), but is not soluble in organic or alkali solutions. The electric properties of the compound indicated semiconductor characteristics. (tr-auth)

33553 HEAT CONTENT OF MOLTEN URANIUM. L. S. Levinson (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 40: 3584-5(June 15, 1964). (LADC-6212)

The heat contents of γ-phase uranium from 1205 to 1394°K and of molten uranium from 1415 to 1579°K were measured using a drop calorimeter. (auth)

33554 DIRECT DETERMINATION OF NATURAL ORBITALS AND NATURAL EXPANSION COEFFICIENTS OF MANY-ELECTRON WAVEFUNCTIONS. I. NATURAL ORBITALS IN THE GEMINAL PRODUCT APPROXIMATION. Werner Kutzelnigg (Uppsala Univ.). J. Chem. Phys., 40: 3640-7(June 15, 1964).

The approximation of a many-particle wavefunction as an antisymmetrized product of strongly orthogonal geminals (APSG) (geminal means two-electron function) was analyzed in terms of its natural expansion. APSG wavefunctions have very simple and interesting properties. The generating spin geminals (GSG) are automatically natural spin geminals (NSG) of the system with Occupation Number 1 (in the Löwdin normalization); 1 is the upper bound for the eigenvalues of the two-particle density matrix for wavefunctions of this type. The natural spin orbitals (NSO) of the GSG are automatically NSO of the total wavefunction and of all the NSG. A generalized paired orbital function is defined in terms of its natural expansion. It contains the APSG type as well as the Bardeen-Cooper-Schrieffer (BCS) functions as special cases. Integrodifferential equations determining the NSO and their expansion coefficients for an APSG function were derived for the special case of a singlet state by minimizing the total electronic energy. An iterative resolution procedure is proposed. When the state under consideration can be regarded as a closed-shell state the first iteration step may already be a good approximation. In this case the equations become very simple and can be given a straightforward physical interpretation. Finally possible refinements of the theory are discussed. (auth)

33555 GASEOUS ION RECOMBINATION RATES. [PART] III. Terry S. Carlton and Bruce H. Mahan (Univ. of California, Berkeley). J. Chem. Phys., 40: 3683-7 (June 15, 1964). (UCRL-11134)

The rate constants for the bimolecular recombination of gaseous ions in three different systems were determined. The results suggest that the recombination rate constant is not particularly sensitive to the chemical identity of the ions, and that complexes between ions and neutral atoms are important even at pressures below 10 mm Hg. (auth)

33556 QUENCHING AND TEMPERATURE DEPENDENCE OF FLUORESCENCE IN RARE-EARTH CHELATES. M. L. Bhaumik (Electro-Optical Systems, Inc., Pasadena, Calif.). J. Chem. Phys., 40: 3711-15(June 15, 1964).

Temperature dependence of the fluorescence quantum yield and decay time of several rare-earth chelates were studied in an attempt to understand the quenching mechanisms in these compounds. It was observed that the quenching in either the ligand or the ion is reduced by lowering the amplitude of molecular vibrations. This indicates that a major part of the fluorescence quenching in rare-earth chelates occurs due to coupling of the electronic states to the environment through molecular vibrations. The results of the measurements also indicate that the shielded 4f orbitals of the rare-earth atoms become more impervious to quenching when they are incorporated into a chelate. Importance of these results in connection with liquid laser research is discussed. (auth)

33557 VAPOR PRESSURES OF SOME DEUTERATED ETHANES. W. Alexander Van Hook (Univ. of Tennessee, Knoxville). J. Chem. Phys., 40: 3727-8(June 15, 1964).

Vapor pressure measurements were made on highly purified samples of 1,1- and 1,2-$C_2H_4D_2$ and 1,1,1- and 1,1,2-$C_2H_3D_3$ at 115 to 200°K. The vapor pressure ratios were corrected for gravity, temperature of mercury columns, capillary depression, and the isotopic and geometric impurity levels. The results form the second independent confirmation of the statistical theory of isotope effects in condensed systems as applied to systems exhibiting higher-order quantum effects. The presence of quantum effects is evidenced by the inverse isotope effect between ordinary and the dueterated ethanes, by deviations from the law of the mean, by the difference in vapor pressure between the equivalent isotopic isomers, and by the maxima in the vapor-pressure-temperatures curves for the deuterated vs protiated species. (P.C.H.)

33558 SHIELDING ANISOTROPIES IN XENON FLUORIDES. M. Karplus, C. W. Kern, and D. Lazdins (Columbia Univ., New York). J. Chem. Phys., 40: 3738-9 (June 15, 1964).

An analysis was made to determine whether the anisotropy measurement is consistent with a theoretical model that has been proposed for the chemical shifts of fluorine and xenon in xenon fluorides. From the theoretical results, the sign of the shielding anisotropy of 19F in XeF_4 was determined. (P.C.H.)

33559 MÖSSBAUER EFFECT EVIDENCE FOR THE EXISTENCE AND STRUCTURE OF $XeCl_4$. G. J. Perlow and M. R. Perlow (Argonne National Lab., Ill.). J. Chem. Phys., 41: 1157-8(Aug. 15, 1964).

Evidence for the existence of $XeCl_4$ is presented, and a measurement of quadrupole coupling, which connects its structure with that of the square planar substances XeF_4 and ICl_4^- is described. The technique used was the Mössbauer effect of the 40-kev gamma ray emitted in the transition from the first excited state to the ground state of ^{129}Xe, following the beta decay of ^{129}I. (P.C.H.)

33560 ELASTIC AND REACTIVE SCATTERING OF K BY HCl AND HI IN CROSSED MOLECULAR BEAMS. M. Ackerman, E. F. Greene, A. L. Moursund, and J. Ross (Brown Univ., Providence). J. Chem. Phys., 41: 1183-96 (Sept. 1, 1964).

The elastic and reactive scattering of K by HCl and HI was measured at several relative energies in experiments with crossed molecular beams. The interpretation follows that presented previously for K + HBr, with some improvements. For both systems the measurements on K show rainbow scattering, and from it parameters were calculated for the exp-six potential. From the elastic scattering at large angles and a two-body model for it, the probability of reaction is deduced as a function of the potential energy at the distance of closest approach of the reactants. For K + HCl the potential parameters are $\epsilon = 0.45 \pm 0.02$ kcal/mole and $r_m = 3.2 \pm 0.3$ Å for $\alpha = 12$ (assumed). The activation energy is 0.55 ± 0.1 kcal/mole, as determined from the threshold of the probability of reaction, and is probably just the change in zero-point energy for this endothermic reaction. There are indications that the probability of reaction increases when the potential energy is sufficient for the product KCl to be formed in excited vibrational states. The application of the two-body model at the thresholds of formation of KCl allows another determination of r_m which is in good agreement with the value obtained from the rainbow scattering. The total reaction cross section as obtained from the probability of reaction is 3.9 Å^2 at $\bar{E} = 2$ kcal/mole. No measurements could be made on KCl. For K + HI the potential parameters are $\epsilon = 0.67 \pm 0.02$ kcal/mole and $r_m = 4.2 \pm 0.2$ Å for $\alpha = 12$ (assumed). The activation energy of this exothermic reaction is 0.2 ± 0.1 kcal/mole as determined from the threshold of the probability of reaction. The total reaction cross section as a function of relative energy was obtained from measurements on KI and from the probability of reaction deduced from the elastic scattering. These two measures of the amount of KI produced agree within a factor of 2, which is the reproducibility of the measurements on KI. At a relative energy of 2 kcal/mole the total reaction cross section is 28 Å^2. (auth)

33561 LASER PHENOMENA IN EUROPIUM CHELATES. IV. CHARACTERISTICS OF THE EUROPIUM BENZOYLACETONATE LASER. A. Lempicki, H. Samelson, and C. Brecher (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). J. Chem. Phys., 41: 1214-24 (Sept. 1, 1964).

The properties of the europium benzoylacetonate laser are described in detail. The effect of an extremely high absorption constant is demonstrated by comparing outputs obtained from cells 0.47 and 0.10 cm in diameter. The outputs are quite different as revealed by a study of far- and near-field patterns, relaxation oscillation, and spectral output. Computed and measured thresholds were compared with those of ruby crystals. Measurements of the energy output of the laser and an estimate of the losses in the resonator are reported. (auth)

33562 ENERGY LEVELS OF Er^{3+} IN LaF_3 AND COHERENT EMISSION AT 1.61 μ. William F. Krupke (Aerospace Corp., Los Angeles) and John B. Gruber. J. Chem. Phys., 41: 1225-32(Sept. 1, 1964).

The analysis of the absorption spectrum of Er^{3+} in LaF_3 was extended into the ultraviolet region to 2000 Å. A number of fluorescence lines recently observed in the region from 3000 to 25000 Å is also reported. Based on the best over-all agreement between the predicted free-ion $4f^{11}$ SLJ states and 21 experimentally observed levels for Er^{3+} in LaF_3, a set of atomic wavefunctions was found for the ion based on $F_2 = 435.7$ cm^{-1}, $F_4 = 67.21$ cm^{-1}, $F_6 = 7.388$ cm^{-1}, and $\zeta = 2350.8$ cm^{-1}. Laser experiments are described and the details of coherent emission found at 1.61 μ are presented. (auth)

33563 THEORY OF NUCLEAR MAGNETIC SHIELDING IN DIATOMIC MOLECULES. H. J. Kolker and M. Karplus (Columbia Univ., New York). J. Chem. Phys., 41: 1259-66 (Sept. 1, 1964).

A variation-perturbation method is employed for the calculation of the magnetic shielding tensor for the nuclei of a series of diatomic molecules (H_2, Li_2, N_2, F_2, LiH, HF, LiF). The SCF–LCAO–MO functions of Ransil were used as unperturbed solutions and polynomials were introduced to represent the orbital perturbations. For certain nuclei (F in HF, N in N_2), special perturbation functions were required to account for the pi-orbital nodes. Although no total shielding measurements were available, the paramagnetic contributions could be compared with those calculated from spin–rotational constants. Good agreement was found for H_2, H in LiH and HF, Li and F in LiF, but larger errors appear for the other nuclei. Estimates for the shielding anisotropy $\Delta\sigma^N$ and average shielding $\langle\sigma^N\rangle$ of some of the nuclei are given that should be accurate to ±10%. Since relative chemical shifts for H, Li, and F in several molecules can be obtained from these results, some experimental tests of the theory by standard NMR measurements are possible. (auth)

33564 THEORETICAL INVESTIGATIONS OF REACTIVE COLLISIONS IN MOLECULAR BEAMS: K + CH_3I. M. Karplus and L. M. Raff (Columbia Univ., New York). J. Chem. Phys., 41: 1267-77(Sept. 1, 1964).

The formulation and results of a dynamical quasiclassical calculation of the reactive scattering of K + CH_3I to yield KI + CH_3 are reported. With a Blais–Bunker interaction potential V_B and the approximation that the CH_3 group can be treated as a single atom, Hamilton's equations of motion were solved to determine collision trajectories as a function of initial conditions. By appropriate Monte Carlo averaging over certain of the initial variables, the desired attributes of the reactive scattering were evaluated; these include the total reaction cross section S_r, the differential reaction cross section $\sigma_r(\Theta)$, the partitioning of the exothermicity of the reaction among the degrees of freedom of the products, and the distribution of angular momentum between the products molecule (J′) and relative orbital motion (L′). A detailed examination was made of the relation between the results obtained from two-dimensional (2-D) and from three-dimensional (3-D) trajectories. It was found that, although S_r and the energy partitioning are similar in the 2-D and 3-D cases, the form of $\sigma_r(\Theta)$ and the angular momentum distribution are different. Comparison with the crossed molecular-beam data available for this system showed that the 3-D calculation with the potential V_B yields a reasonable reaction-energy distribution, but total and differential cross sections in disagreement with the experimental information; i.e., S_r equals 400 Å^2 instead of the measured value of 7 Å^2, and $\sigma_r(\Theta)$ is independent of angle instead of being strongly peaked in the backward direction. An analysis of the scattering trajectories showed that the erroneous results derive from the neglect in the interaction potential of an attenuation factor that decreases the K, I attraction for an I atom that is part of a CH_3I molecule. Introduction of such a three-body term yields cross sections and energy distributions in qualitative agreement

with the experimental data. Additional measurements were required to test the theoretical angular momentum distribution. (auth)

33565 LIGAND FIELD SPECTRA OF SOME NEW LASER CHELATES. L. J. Nugent, M. L. Bhaumik, S. George, and S. M. Lee (Electro-Optical Systems, Inc., Pasadena). J. Chem. Phys., 41: 1305-12(Sept. 1, 1964).

The high-resolution emission spectra from microcrystals of three new europium benzoylacetonate chelates, EuB_4HP, EuB_4HM, and EuB_4HD, are presented and discussed in terms of the ligand field symmetries. It was established that the ligand fields about the Eu^{3+} in these compounds must be of one of the point symmetries C_1, C_{1h}, C_2, or C_{2v}; however, the exact symmetry in each case cannot be determined from the evidence presented. The emission spectra of EuB_4HP and EuB_4HM are found to be identical, indicating that the ligand field magnitudes and symmetries are the same for these cases. The emission spectra of EuB_4HD, on the other hand, is considerably different, indicating that the magnitude and/or the symmetry of the ligand field in this compound must be different from the other chelates. A vibronic energy level for EuB_4HP, probably corresponding to an europium molecular vibrational mode, was determined to be 37 cm^{-1} above the $^5D_0$ energy level, and 33 cm^{-1} above the $^7F_0$ energy level. A general tendency is noted in these spectra for the lines terminating on the higher ligand energy levels to be shaded toward longer wavelengths. This may be attributed to the greater number of vibronic states, which are closer and more thoroughly mixed with the higher-lying ligand field states. (auth)

33566 RELAXATION OF OPTICALLY PUMPED CESIUM ATOMS BY DIFFERENT BUFFER GASES. S. Legowski (Brandeis Univ., Waltham, Mass.). J. Chem. Phys., 41: 1313-17(Sept. 1, 1964).

The decay of spin polarization of optically pumped cesium atoms at room temperature in the inert buffer gases helium, neon, and argon, was investigated at different buffer gas pressures. It was found that the decay of the spin polarization is not a simple exponential but can be described as the sum of two exponentially decaying modes, which are interpreted as two diffusion modes. The diffusion coefficients for cesium in helium, neon, and argon were found to be 0.37, 0.24, and 0.19 cm^2/sec, and the collision depolarization cross sections are 2.5×10^{-24}, 8.4×10^{-24}, and 26×10^{-24} cm^2, respectively. (auth)

33567 THERMODYNAMIC EFFECTS OF MIXING LIGHT AND HEAVY WATER. Alfred Narten (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 41: 1318-21 (Sept. 1, 1964).

The thermodynamic functions for the isotopic exchange reaction $H_2O + D_2O = 2HDO$ in the gas and liquid states were computed from recent experimental data. They differ from previously published values. Excess functions for liquid mixtures of the water isotopes were derived. For ideal solutions of the water isotopes, these functions can be evaluated numerically. The calculated excess enthalpy of mixing is in agreement with the experimental heat of mixing. The possibility of nonideal behavior of isotopic water solutions is discussed. (auth)

33568 ISOTOPE SHIFTS AND THE VIBRATIONAL STRUCTURE IN SOME WEAKER SYSTEMS OF N_2. D. Mahon-Smith (University Coll., Dublin) and P. K. Carroll. J. Chem. Phys., 41: 1377-82(Sept. 1, 1964).

The emission spectrum of $^{15}N_2$ was studied in the region 2000–9000 Å with a view to investigating the vibrational structure of some of the weaker systems. In the cases of the Herman infrared bands and the Gaydon-Herman green bands, it was possible to decide between alternative vibrational schemes that have been suggested. Observations were also made on the Goldstein-Kaplan and the $B' \rightarrow B$ systems. In the near-ultraviolet spectrum it is shown that the $h \rightarrow a$, $s' \rightarrow a$, $r' \rightarrow a$, $m \rightarrow a$, and $d \rightarrow a$ progression all arise from upper levels with $v > 0$. The possibility that some of these progressions may belong to a single system is discussed. The vibrational schemes for the fifth positive and Kaplan's first and second systems were confirmed. Some new bands of $^{15}N_2$ corresponding apparently to hitherto unobserved transitions are reported. (auth)

33569 APPEARANCE POTENTIALS BY THE RETARDING POTENTIAL-DIFFERENCE METHOD FOR SECONDARY IONS PRODUCED BY EXCITED-NEUTRAL, EXCITED ION-NEUTRAL, AND ION-NEUTRAL REACTIONS. C. E. Melton and W. H. Hamill (Univ. of Notre Dame, Ind.). J. Chem. Phys., 41: 1469-74(Sept. 1, 1964).

A time-of-flight mass spectrometer with a retarding potential-difference ion source was used to measure appearance potentials and ionization efficiency curves for secondary ions. Reaction types studied include excited neutral-molecule, charge-transfer, attachment, and branching ion-molecule reactions. The systems investigated were argon, krypton, methane, acetylene, 1-3 butadiene, ethyl iodide, and methane–krypton mixtures. Rare-gas molecular ions from excited neutral-molecule reactions were observed for Ar_2^+ with appearance potentials at 14.94 ± 0.02, 15.2 ± 0.1, and 15.8 ± 0.1 ev and for Kr_2^+ at 13.20 ± 0.02, 13.8 ± 0.1, and 14.0 ± 0.1 ev. A charge-transfer reaction for $Kr - CH_4$ produced CH_3^+ at 14.6 ± 0.1 ev corresponding to $Kr^+(^2P_{\frac{1}{2}})$. The activated complex formed by $C_4H_6^+ + C_4H_6$ from butadiene produces six different secondary ions. Ionization efficiency curves of the six secondary ions showed the same structure in the energy range to 2 ev above onset. Similar results were observed for two competitive reactions formed by $C_2H_2^+ + C_2^{**}$ from acetylene, for energies below 14.5 ± 0.2 ev. At h[illegible]r energies, the ratio of secondary $C_4H_3^+/C_4H_2^+$ chang[illegible] a factor of two thereby demonstrating the influence [illegible] reactions of excited $C_2H_2^{**}$. The predominant excitation level for the excited reaction was 17.0 ± 0.2 ev. Ionization efficiency curves of the primary and secondary ions in the energy range near onset for all systems were essentially identical except for the collision complex $C_4H_{10}I_2^+$, which was slightly different from that of the primary $C_2H_5I^+$ ion. The technique greatly improves the reliability of correlating primary ions with secondary ions and provides detail not otherwise measurable. (auth)

33570 VAPOR PRESSURE OF NEPTUNIUM. H. A. Eick (Michigan State Univ., East Lansing) and R. N. R. Mulford. J. Chem. Phys., 41: 1475-8(Sept. 1, 1964).

The vapor pressure of liquid neptunium metal in the temperature range 1700 to 1950°K, as determined by the Knudsen effusion technique, may be described by the equation $\log p(atm) = -(20{,}610 \pm 1280)/T + (5.10 \pm 0.70)$. The experimental heat and entropy of vaporization are $\Delta H^0_{1800} = 94.3 \pm 5.9$ kcal/mole, and $\Delta S^0_{1800} = 23.3 \pm 3.2$ cal/mole · deg, and the extrapolated normal boiling point of the metal is 4175°K. The neptunium specimen contained 0.56 wt % plutonium-239, and the partial pressure of that species over the solution may be described by the equation $\log p(atm) = -(19{,}051 \pm 538)/T + (3.29 \pm 0.30)$. (auth)

33571 STABLE DIVALENT RARE-EARTH-ALKALINE-EARTH HALIDE SYSTEMS. Z. J. Kiss and P. N. Yocom

(RCA Labs., Princeton, N. J.). J. Chem. Phys., 41: 1511-12(Sept. 1, 1964).

A chemical means was found by which a very large fraction of trivalent rare earth ions in alkaline earth fluorides could be converted to the divalent state in a fashion that leaves the divalent rare earth stable under normal conditions. The conversion is achieved by heating the trivalent containing crystal in an atmosphere of the appropriate alkaline earth metal. For calcium fluoride, the crystal is sealed in an evacuated fused silica ampoule with a piece of calcium metal. The ampoule is heated for several hours in the temperature range 750 to 950°C. The lower the temperature, the longer the time. Conditions for other compounds are also discussed. (P.C.H.)

33572 FURTHER INVESTIGATIONS OF RuC AND OsC. Charles P. Kempter (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 41: 1515-16(Sept. 1, 1964). (LADC-6423)

An investigation on hexagonal (WC-type) RuC and OsC showed that the yield of RuC and OsC was strongly dependent on the metal : graphite ratio of the starting material, the synthesis temperature, and the heating time, thus suggesting that the two carbides are metastable or have a narrow range of temperature stability. The best yields were obtained with specimens having a 1 : 10 molar ratio, which were heated at 2600°C for 4 hr. (P.C.H.)

33573 HYDROGEN-DEUTERIUM KINETIC-ISOTOPE EFFECT: THE PROBLEM OF POTENTIAL-ENERGY SURFACE. J. G. Davy, C. R. Guerra, H. S. Johnston, C. F. Weaver, and C. E. Young (Univ. of California, Berkeley). J. Chem. Phys., 41: 1517-18(Sept. 1, 1964).

Values obtained by the LEP and LEPS methods were compared with experimental data for the potential-energy surfaces for three-atom hydrogen-transfer reactions. A calculation of the kinetic isotope effect in the reaction $CF_3 + CHD_3$, employing a linear three-atom model for the activated complex and the LEP method, is reported. The ratio f of Coulombic to Coulombic-plus-exchange energy was adjusted parametrically (0.1480) to give the previously determined potential energy of activation (16.4 kcal/mole). The failure of the LEP method was found to be total. It is recommended that the LEP method not be used, even for qualitative purposes. (P.C.H.)

33574 MISSING BAND IN THE SPECTRUM OF THE TRIPOSITIVE AMERICIUM ION. John G. Conway (Univ. of California, Berkeley) and B. R. Judd. J. Chem. Phys., 41: 1526(Sept. 1, 1964). (UCRL-11401)

Two alternative explanations are given for the missing band for the transition $^7F_0 \rightarrow {}^5D_1$, which should lie at 17,500 cm^{-1} in the spectra of Am^{3+}. It is suggested that either the calculation is inadequate, and there is, in fact, no level in the vicinity of 17,500 cm^{-1} above $^7F_0$; or else the transition probability for $^7F_0 \rightarrow {}^5D_1$ is exceptionally small. (P.C.H.)

33575 EFFECT OF METAL IONS ON BOVINE SERUM ALBUMIN-STABILISED EMULSIONS WITH PARTICULAR REGARD TO SPECIFIC FLOCCULATION EFFECT AND CATION BINDING. S. N. Srivastava (Agra Coll., India). J. Indian Chem. Soc., 41: 203-11(Mar. 1964).

A study on the effect of certain inorganic cations on petroleum (bp 120-60°)-water emulsions, stabilized by bovine serum albumin (BSA), showed that the cations bind to the protein surface under suitable conditions of pH and surface potentials, resulting in the specific flocculation of the hydrocarbon droplets. This specific binding permits evaluation of certain adsorption parameters, using a theoretical treatment based on the stability theory of hydrophobic colloids. (auth)

33576 ON THE FORMATION OF $UC_{1-x}N_x$. Masahiro Katsura, Shosuke Imoto, and Tadao Sano (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 1: 22-6(Apr. 1964).

From the known values of the free energy of formation of several uranium compounds in the ternary system U–C–N, the condition of stable existence of the solid solution between UC and UN, $UC_{1-x}N_x$, was determined; and several ternary sections were obtained at constant temperature and constant nitrogen pressure. In order to examine the results, some experiments were carried out under different conditions of temperature and nitrogen pressure. From these results, it is concluded that the stable compounds which exist in the ternary system U–C–N change from larger to smaller value of $(\log P_{N_2})/T$ in the following order: U_2N_3 and carbon, $UC_{1-x}N_x$ and carbon, $UC_{1-x}N_x$ and carbon, and $UC_{1-x}N_x$, UC_2 and metallic uranium. Under the condition of high temperature and low pressure, that is, a very small value of $(\log P_{N_2})/T$, the range of stable existence of the solid solution, $UC_{1-x}N_x$, is very small. (auth)

33577 THE ISOTOPIC EXCHANGE REACTION BETWEEN U(IV) AND U(VI) IONS IN A MIXED SYSTEM OF ACIDIC SOLUTION AND CATION EXCHANGE RESIN. I. EXPERIMENTAL METHOD AND EXCHANGE REACTION RATE. Junichi Shimokawa, Gunji Nishio, and Takuji Komori (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 51-7(May 1964).

The exchange rate of uranium isotopes was investigated in a mixed system of natural U(VI) solution and cation exchange resin containing depleted U(IV) and U(VI) ions at various acid concentrations and temperatures. The experiments showed the presence of two isotopic exchange paths. Activation energies, hydrogen ion concentration dependences, and suitability of the exchange resin were considered also. (D.C.W.)

33578 ABSORPTION SPECTRUM OF ASTATINE. Ralph McLaughlin (Univ. of California, Berkeley). J. Opt. Soc. Am., 54: 965-7(Aug. 1964). (UCRL-11253)

The absorption of atomic At was investigated using a method that detected as little as 0.2 ng of At. The method is an adaptation of capillary-absorption-cell spectroscopy in which gaseous samples are used. Two lines with wavelengths of 2244.01 and 2162.25Å were observed and were tentatively assigned to the $6p^5\ {}^2P^0_{3/2} - 6p^47s\ {}^4P_{5/2}$ and $6p^5\ {}^2P^0_{3/2} - 6p^47s\ {}^4P_{3/2}$ transitions, respectively. The assignments of two resonant lines of Po were confirmed. (D.C.W.)

33579 PENETRATION EFFECTS IN THE ^{2}F-SERIES OF CsI. Anders Froeman, Jan Linderberg, and Yngve Oehrn (Uppsala Univ.). J. Opt. Soc. Am., 54: 1064-5(Aug. 1964).

It is shown that for penetration of a series electron into the ion core, two different effects can be distinguished and that the 4-f level of CsI should exhibit such an effect, while the other f levels are practically hydrogenic. (D.C.W.)

33580 POLARIZATION FORMULA FOR THE ^{2}F-SERIES OF CsI. Kjell Bockasten (Uppsala Univ.). J. Opt. Soc. Am., 54: 1065(Aug. 1964).

The term values for CsI were calculated from a polarization formula and compared with values observed by Kleinman. Perfect agreement was noted for the accurately known 5-9 f ^{2}F terms, and the formula gave the series limit very accurately. (D.C.W.)

33581 SURFACE TEMPERATURE MEASUREMENTS ON BURNING SOLIDS. A. Greenville Whittaker and David C. Barham (Sandia Corp., Albuquerque, N. Mex.). J. Phys. Chem., 68: 196-9(Jan. 1964). (SC-R-756)

Surface temperature measurements were made on catalyzed ammonium nitrate, hydrazine nitrate, and ammonium nitrate-hydrazine nitrate eutectic. Preliminary results using high speed photography indicated that each one of the systems formed a liquid layer at the burning surface of sufficient depth that the thermocouple would probably be completely covered by liquid before it reached the burning surface. The catalyst used was chromic oxide. The striking feature about the surface temperature is that in all cases the surface temperature was constant over a rather wide range of burning rates. Another outstanding feature of the results is that the surface temperatures for ammonium nitrate and the ammonium nitrate-hydrazine nitrate eutectic were the same; whereas the surface temperature for hydrazine nitrate was considerably lower than the other two. Data are tabulated. (P.C.H.)

33582 PHASE EQUILIBRIA IN THE SYSTEM NaF/BeF_2/ThF_4. R. E. Thoma, C. F. Weaver, H. Insley, and H. A. Friedman (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 19: 406-11(Aug. 1964).

The equilibrium phase diagram of the condensed system NaF/BeF_2/ThF_4 is presented. Liquid/solid phase transitions were found in the temperature range from ~300 to 1100°C. The phase diagram of the system is based on data obtained from thermal analysis and thermal-gradient-quenching experiments; phase identifications were made using a polarizing light microscope and x-ray diffractometer. Thirteen crystalline phases are precipitated as primary phases from molten NaF/BeF_2/ThF_4 solutions: 4NaF · ThF_4, 7NaF · 2ThF_4, 2NaF · ThF_4, 3NaF · 2ThF_4, α- and β-NaF · ThF_4, NaF · 2ThF_4, 2NaF · BeF_2, NaF · BeF_2, NaF · BeF_2 · 3ThF_4, NaF, BeF_2, and ThF_4 solid solution. The character, location, and temperature of the fourteen invariant and singular points in the system were established. The ternary system is comprised of two subsystems, NaF/2NaF · ThF_4/2NaF · BeF_2 and 2NaF · ThF_4/ThF_4/BeF_2/2NaF · BeF_2, separated by the quasi-binary section, 2NaF · BeF_2/2NaF · ThF_4. The lowest liquidus temperatures in the respective subsystems were found at the eutectics, 72NaF/22BeF_2/6ThF_4 (mole %), m.p. 509°C, and at 55NaF/43BeF_2/2ThF_4 (mole %), m.p. 320°C. (auth)

33583 FAST-PASSAGE EFFECTS IN THE NUCLEAR MAGNETIC RESONANCE OF Fe^{57} IN PURE IRON METAL. David L. Cowan and L. Wilmer Anderson (Univ. of Wisconsin, Madison). Phys. Rev., 135: A1046-50(Aug. 17, 1964).

The nuclear magnetic resonance of ^{57}Fe in pure iron metal was examined. The results of the experiments were analyzed in terms of Portis' theories of saturation and fast passage in inhomogeneously broadened spin systems. The principal results are the following: The value of the enhancement factor for iron $\eta = 2000$ independent of temperature, the values of the spin-lattice relaxation time $T_1 = 0.25$ msec at T = 295°K, and $T_1 = 1.3$ msec at T = 77°K, and the fact that the dispersion mode of the nuclear susceptibility is coupled out into the power absorbed more strongly than the absorption mode (in the limit of zero saturation). In addition it is found that the distribution of hyperfine fields is plotted directly due to fast-passage effects. This is identified as a fast-passage effect by the observation that the signal amplitude does not increase linearly with the modulation amplitude and by other tests. (auth)

33584 BROMINE NUCLEAR MAGNETIC RESONANCE IN FERROMAGNETIC $CrBr_3$. A. C. Gossard (Bell Telephone Labs., Murray Hill, N. J.), V. Jaccarino, E. D. Jones J. P. Remeika, and R. Slusher. Phys. Rev., 135: A1051-5 (Aug. 17, 1964).

The nuclear magnetic resonance of ^{79}Br and ^{81}Br was studied in ferromagnetic $CrBr_3$. The ^{79}Br resonances were observed at 53.744 ± 0.010 and 130.64 ± 0.10 Mc, and ^{81}Br resonances were observed at 55.321 ± 0.010 and 121.61 ± 0.10 Mc in zero applied magnetic field at 1.48°K. This compares with quadrupole frequencies of 101.82 and 85.73 Mc in the paramagnetic state observed for the same two isotopes. The shift in frequencies produced in the ferromagnetic state arises predominantly from the magnetic hyperfine field H_N at the bromine sites. The observed resonant frequencies and their temperature dependence can be explained by assuming $|H_N| \sim 36$kOe at 0°K. Nuclear spin-lattice relaxation rates at 1.3 and 4.2°K are reported. The observed ^{79}Br and ^{81}Br rates are an order of magnitude faster than the rate calculated for relaxation of the nuclei by the Raman scattering of spin waves. (auth)

33585 PRESSURE DEPENDENCE OF THE ELECTRIC FIELD GRADIENT IN METALLIC INDIUM. W. J. O'Sullivan and J. E. Schirber (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 135: A1261-4(Aug. 31, 1964).

The shift of the $^{115}In_{|7/2|\leftrightarrow|9/2|}$ nuclear quadrupole resonance (NQR) in indium metal was measured at 25.5°C as a function of hydrostatic pressure to 8 kbar. In addition, the linear compressibilities at 25.5°C and the linear thermal-expansion coefficients and resonance-frequency temperature dependence in the room-temperature region were measured. Since the electric field gradient is a function of three variables, these measurements are insufficient to separate the explicit dependences. The obvious third experiment, the effect of uniaxial stress on the NQR, is not feasible, as it would require detection of the broad NQR of indium in the skin depth of a single crystal. It was inferred that the major contribution to the change in field gradient is due to the change in distortion parameter $(c/a)-1$. A possible solution to this problem at one temperature is discussed. (auth)

33586 ELECTRONIC ENERGY BANDS IN STRONTIUM TITANATE. A. H. Kahn and A. J. Leyendecker (National Bureau of Standards, Washington, D. C.). Phys. Rev., 135: A1321-5(Aug. 31, 1964).

A theoretical examination of the electronic energy bands of cubic strontium titanate was performed by application of the LCAO (linear combination of atomic orbitals) methods. Diagonal energies were determined from ionization potentials and crystalline fields based on a point-charge model for the ions. The ionic charges were adjusted to give agreement with the observed energy gap. Overlap integrals were estimated from free-ion wave functions. For the crystals studied, the calculations led to filled valence bands derived primarily from oxygen 2p orbitals and empty conduction bands derived predominantly from titanium 3d orbitals. In cubic strontium and barium titanates, there are six lowest-conduction-band ellipsoids lying along ⟨100⟩ directions of k space with minima probably at the edges of the Brillouin zone. The longitudinal mass is about 20-50 m_0 and the transverse mass about 1 m_0. Spin-orbit splitting removes degeneracy at k = 0 and leads to additional conduction bands several hundredths of an ev above the lowest conduction band. Comparison is made with experimental data on conductivity, Hall effect, thermoelectric power, reflectivity, and soft x-ray emission. Results are in substantial agreement with experiment. (auth)

33587 PARAMAGNETIC RESONANCE OF S-STATE IONS IN METALS OF HIGH PARAMAGNETIC SUSCEP-

TIBILITY. D. Shaltiel (Bell Telephone Labs., Murray Hill, N. J.), J. H. Wernick, H. J. Williams, and M. Peter. Phys. Rev., 135: A1346-62(Aug. 31, 1964).

The paramagnetic resonance of Gd^{3+} in metals shows g shifts with respect to the free ionic g value which are due to the valence-electron polarization in metallic hosts, and the effective exchange interaction of Gd^{3+} with these valence electrons. These shifts were studied in metals and intermetallic compounds with high paramagnetic susceptibility such as Pd, Ni_5Y, and Pd_3U and in many alloys involving these metals and compounds. The effective exchange interaction is found to be generally much smaller than expected from the atomic spectra. It is negative for valence bands of d character and positive in valence bands of 5f and s character, and is therefore not the result of simple atomic exchange only. The shape of the Gd resonance lines gives information on the spatial variations in the valence-electron polarization of the host metals. Thus, it was found that Pd alloyed with La or H segregates into two phases. The valence-electron polarization can be altered by admixture of other magnetic ions, and it was therefore possible to measure the exchange interaction for many rare earths and Fe, Co, Ni in Pd, and some rare earths in Ni_5Y. The Gd line shape in these experiments allowed a study of the nonlocal character of the valence-electron susceptibility, and it appears that in Pd and in Ni_5Y this susceptibility has a larger range than predicted by the free-electron calculation of Ruderman-Kittel-Yosida. (auth)

33588 THE DIFFERENCE IN VAPOUR PRESSURE BETWEEN NORMAL AND EQUILIBRIUM HYDROGEN. VAPOUR PRESSURE OF NORMAL HYDROGEN BETWEEN 20°K AND 32°K. A. Van Itterbeek, O. Verbeke, F. Theewes, K. Staes, and J. De Boelpaep (Instituut voor Lage Temperaturen en Technische Fysica, Leuven, Belg.). Physica, 30: 1238-44(June 1964).

In the temperature range from 20 to 32°K, the difference in vapor pressure between normal- and equilibrium hydrogen was measured simultaneously with the absolute vapor pressure of normal hydrogen. Equations were obtained to describe the results. The results are compared with those of other investigations. (auth)

33589 STABLE DIVALENT RARE EARTHS IN ALKALINE EARTH HALIDES BY SOLID-STATE ELECTROLYSIS. Francis K. Fong (Air Force Systems Command, Wright-Patterson AFB, Ohio). R C A Rev., 25: 303-7(June 1964).

An electrolytic process for the reduction of rare-earth ions in alkaline-earth halides is described. Trivalent dysprosium and thulium in calcium fluoride were successfully reduced to the divalent state. The reduced samples were stable with respect to optical bleaching, and thermoluminescence accompanying the thermal reoxidation of the rare-earth ions was not observed. (auth)

33590 DETERMINATION OF THE PHYSICOCHEMICAL FORM OF RADIOELEMENTS BY PAPER ELECTROPHORESIS WITH DETECTION OF RADIOACTIVITY. J. Lafuma, Ch. Sachs, and J.-L. Funck-Brentano (CEN, Fontenay-aux-Roses, France and Hopital Necker, Paris). Rev. Franc. Etudes Clin. Biol., 8: 700-6(1963). (In French)

A technique combining paper electrophoresis and radioactivity recording, which renders possible the identification of the physico-chemical state of one or several radioisotopes in a liquid medium is described. The ease and rapidity of the technique are outlined. The method is based on a recording of the shifts in the sites of radioactivity as they pass along the test paper. Under the experimental conditions used, certain ionized radioisotopes (^{24}Na, ^{42}K, ^{137}Cs, ^{86}Rb, and ^{131}I) showed rates of migration of 5.0–8.3 cm/hr. Elements in a colloidal state (^{133}Ba, ^{90}Y, and ^{144}Ce) did not migrate, while ^{59}Fe combined with proteins migrated at a very slow rate. In serum containing ^{90}Sr and ^{90}Y, it was possible to demonstrate both ionized and colloidal forms of the 2 elements. For ^{133}Ba in solution at pH 5, it was possible to demonstrate both ionized (migrating) and colloidal (non-migrating) forms of the element. The separation of ^{24}Na and ^{42}K electrophoretically is described. The limitations of the method are also discussed. (P.C.H.)

33591 X-RAY DIFFRACTION STUDIES ON DYSPROSIUM AT HIGH PRESSURES. John C. Jamieson (Univ. of Chicago). Science, 145: 572-4(Aug. 7, 1964).

Dysprosium was studied at pressures up to about 160 kilobars, well above the transition reported near 50 kilobars by others. It showed no definite structural alteration from hexagonal close-packed structure throughout this range. It is suggested that the 50-kilobar transition is most likely electronic or magnetic in nature, or that the metal undergoes a hexagonal stacking rearrangement. (auth)

33592 HIGH PRESSURE: EFFECT ON DYSPROSIUM. P. C. Souers and G. Jura (Univ. of California, Berkeley). Science, 145: 575-7(Aug. 7, 1964). (UCRL-11207)

The electric resistance of dysprosium was studied in the temperature-pressure range 77 to 200°K and 15 to 120 kb. The variations of the Néel transition with pressure was found to good accuracy, the value of dT_N/dP being -0.62 ± 0.4 deg/kb. From this result, second-order thermodynamic equations yield values of -64×10^{-6} $(°C)^{-1}$ and 4.0×10^{-14} cm^2/dyne for the changes in the coefficient of linear expansion and the compressibility, respectively, at the 1-atm Néel point. The Néel transition disappears at 45 to 55 kb, and no magnetic transitions are seen at higher pressures in the temperature range indicated. The other boundaries in the region investigated were determined but are very uncertain. The cause of the cusp in the isothermal compressions is not clear from the available data. Above the Néel boundary, the pressure dependence of the cusp with respect to temperature, dP/dT, is very small and may even be zero. Below the Néel temperature, dP/dT is uncertain. From isothermal measurements, the value is −1, while from the isobaric measurements a value of −0.25 is obtained. (auth)

33593 XENON HEXAFLUORIDE: PREPARATION OF PURE FORM AND MELTING POINT. Irving Sheft, Thomas M. Spittler, and Francis H. Martin (Argonne National Lab., Ill.). Science, 145: 701-2(Aug. 14, 1964).

Xenon hexafluoride forms an addition compound with sodium fluoride which can be used to separate it from the other xenon fluorides and oxyfluoride. The melting point of pure xenon hexafluoride prepared in this way was 47.7 ± 0.2°C. (auth)

33594 PRECIPITATION OF Sr BY $CaCO_3$ IN CALCAREOUS SOILS AND MEASUREMENT BY CATION-EXCHANGE CAPACITY. E. Halevy and Y. Tzur (Weizmann Inst. of Science, Rehovoth, Israel). Soil Sci., 98: 66-7(July 1964).

A 0.01N $^{85}SrCO_3$ solution was passed through two soil columns and breakthrough activities measured. The Sr concentration reached 68% of its value in the original solution and stayed more or less constant at this level. When the same solution was passed through a column of analytical $CaCO_3$, breakthrough was immediate, but at

about 64% of the original concentration. Measurement of various sections of the soil columns showed that most of the activity was found at the top of the columns. Dissolving of soil carbonate prior to column preparation was followed by production of a normal breathrough curve. The experiments clearly showed that there exists in calcareous soils a mechanism of Sr precipitation by $CaCO_3$, a reaction fast enough to take place in the top fraction of the column length. It was concluded that cation-exchange capacity measurements of calcareous soil with Sr solutions have no meaning. (H.M.G.)

33595 SOLUBILITY OF NITROGEN IN TANTALUM. P. Bunn (P. R. Mallory Co., Burlington, Mass.) and C. Wert. Trans. AIME, 230: 936-7(June 1964).

Measurements of the solubility of nitrogen in tantalum at low temperatures using internal friction methods were plotted together with existing measurements at high temperatures. The solubility is shown from less than 0.5 at. % at 350°C to near 13% at 230°C. (M.C.G.)

33596 THE ELECTROLYSIS OF SOLID LITHIUM SULFATE WITH A MOLTEN ZINC CATHODE. A STUDY OF CATHODE REACTIONS AND ISOTOPE EFFECTS. Arnold Lunden (Chalmers Univ. of Tech., Goteborg). Trans. Chalmers Univ. Technol. Gothenburg, No. 289, 29p. (1964).

The cubic modification of lithium sulfate was electrolyzed using a cathode of molten zinc metal. Several reactions competed at the cathode. Thus lithium was deposited forming a lithium–zinc alloy with up to 20 at. % lithium. Simultaneously, in other reactions the sulfate was reduced to a mixture of lithium oxide, sulfide, sulfite, and thiosulfate. Some zinc sulfide was also formed. Nine experiments, covering the temperature range 600–790°C, were analyzed, and it was found that the branching between deposition and reduction reactions varied from one experiment to another, without any obvious correlation with either the temperature or any other parameter of the experiments. Thus the highest and the lowest current efficiency for metal deposition (81 and 0.7%, respectively) were found for two experiments at nearly the same temperature. At temperatures above 700°C the molten metal cathode penetrated like a dendrite through the solid salt. Some mechanisms that might be responsible for this displacement of the cathode are discussed. At these high-temperature experiments the zone containing reaction products extended a few centimeters beyond the cathode (the tip of the molten dendrite). For the chemical analysis the cell contents were divided into three fractions by dissolving in cold water. The soluble fraction consisted of lithium oxide, sulfite, thiosulfate, and sulfate. The second fraction contained a mixture of lithium and zinc oxides and sulfides, while the third fraction was the lithium–zinc alloy. The lithium isotope abundance ratio was measured for all three fractions, and a significant isotope separation could be detected. Since the chemical composition of the fractions differed from sample to sample, the detected isotope separations show great variations. Thus for the experiments below 700°C either ^{6}Li or ^{7}Li was enriched in the oxide-sulfide mixture, depending on the composition of the fractions, while above 700°C always ^{7}Li was enriched in this mixture. The highest separation factor was 1.04. Regarding the alloy, it was found that the measured isotope separation depended on the composition of the alloy: ^{7}Li was enriched in the samples with less than 4 atomic per cent lithium and ^{6}Li in the other samples. The highest separation factors were in both cases above 1.01. The measured isotope enrichment in the alloy is the result of the isotope effects of three processes: the deposition reaction, reduction reactions between the alloy and the salt, and exchange reactions between alloy and salt. Vycor glass was corroded by the mixture of reaction products under the formation of α-quartz. (auth)

33597 DIPOLE MOMENT OF LINEAR YXY′ MOLECULES SUCH AS $^{16}OC^{18}O$. D. H. Whiffen (National Physical Lab., Teddington, Middx., Eng.). Trans. Faraday Soc., 60: 1198-1201(July 1964).

It is shown that there is a contribution to the dipole moment of linear isotopic molecules of the form YXY′ which depends on the harmonic force constants and the first derivative of the dipole moment with respect to the bending co-ordinate. For $^{16}OC^{18}O$, it is 1.5×10^{-4}D compared to a contribution of 11.5×10^{-4}D, which arises from the anharmonic potential constants and the derivative of the dipole moment with respect to the bond stretching co-ordinate. (auth)

33598 CARBON ISOTOPE EFFECTS IN THE DECARBOXYLATION OF OXALOACETIC ACID. PART I. STUDIES USING ^{13}C. A. Wood. Trans. Faraday Soc., 60: 1263-7(July 1964).

^{13}C kinetic isotope effects in the decarboxylation of oxaloacetic acid and various complexes between it and paramagnetic and diamagnetic rare earth cations were studied at 25°C in aqueous solutions. Normal effects were found in each case, the reactions producing heavy carbon dioxide lagging behind those producing ordinary $^{12}CO_2$. The results for the complexes were similar to one another and less marked than the effect for the uncatalyzed reaction. It is suggested that this difference is due mainly to inductive effects. (auth)

33599 RAPID PREPARATION OF PURE URANIUM SALTS FROM SECONDARY URANIUM MINERALS. Yu. V. Gromtsev and A. I. Egorov. Vopr. Rudn. Geofiz., Min. Geol. i Okhrany Nedr SSSR, No. 3, 111(1961). (In Russian)

The described method consists of carbonate leaching from the mineral and ion exchange purification on a sodium resin. (R.V.J.)

33600 STUDIES ON THE CO-PRECIPITATION OF URANYL ION WITH ZIRCONIUM HYPODIPHOSPHATE. M. R. Zaki (Atomic Energy Establishment, Cairo). Z. Anal. Chem., 199: 420-4(1964).

Studies on the co-precipitation and/or the uptake of uranyl ion by zirconium hypodiphosphate were carried out in hydrochloric acid medium of different normalities. The degree of co-precipitation and/or uptake was found to depend on the acidity, the amount of carrier used, and the temperature at which precipitation of carrier took place. (auth)

33601 MAGNETIC RELAXATION OF Li^{7} NUCLEI IN AQUEOUS SOLUTIONS OF PARAMAGNETIC SALTS. R. K. Mazitov (Kazan State Univ.). Zh. Strukt. Khim., 5: 302-3 (Mar.-Apr. 1964).

Results of time measurements of the longitudinal T_1 and the transverse T_2 relaxations of ^{7}Li and ^{1}H nuclei in aqueous solutions containing paramagnetic ions and Li^{+} ions are given. The measurements were carried out by the spin echo method. Resonance of ^{7}Li nuclei was observed in a 2670 oersted field while proton resonance was observed in a 1030 oersted field, at a frequency of 4.4 megacycles. It was found that the time ratios $T_{1,Li}/T_{2,Li}$ for most paramagnetic solutions studied lie within the limits 1.02–1.07, which indicates a magnetic dipole-dipole mechanism of ^{7}Li nuclei relaxation. An exception was found in certain solutions of Mn^{2+} and VO^{2+} ions, for which the $T_{1,Li}/T_{2,Li}$ ratio

>1.17. Evidently, here the scalar A·I·S interaction between the paramagnetic ion and the ^{7}Li nucleus contributes to transverse relaxation. This agrees with the fact that for solutions of manganese salts the $T_{1,Li}/T_{2,Li}$ ratio becomes larger, as the superfine structural component of the EPR spectra of these same solutions narrows. (OTS)

33602 PROTON RESONANCE IN HYDRATES OF URANIUM PEROXIDE. S. P. Gabuda, Yu. V. Gagarinskii, S. A. Durasova, and A. G. Lundin (Inst. of Physics, Krasnoyarsk, USSR and Inst. of Inorganic Chemistry, Novosibirsk, USSR). Zh. Strukt. Khim., 5: 303-5(Mar.-Apr. 1964).

The position of protons and the nature of water involved in hydrates of uranium peroxide were studied by the method of proton magnetic resonance. Chief attention is given to uranium peroxide tetrahydrate, obtained by the action of excess 30% H_2O_2 on uranyl nitrate, with subsequent washing of the precipitate with water, alcohol, and ether, followed by air drying. Proton magnetic spectra were recorded at a temperature of 290°K. The magnetic field was modulated at 32 cps. Analysis revealed that proton magnetic resonance spectra of the tetrahydrate at 90°K is the sum of a broad component due to paired protons of crystallizational water molecules, and a narrow component due to relatively isolated protons of the OH or OOH groups. (OTS)

33603 KNOWLEDGE OF THE THERMOCHEMISTRY OF REFRACTORY METALS AND ITS APPLICATION IN PREDICTION OF ENGINEERING STRUCTURES. O. Kubaschewski (National Physical Lab., Teddington, Middx., Eng.). p.191-204 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

The use of thermochemical data on refractory metals for calculation of metallurgical equilibrium diagrams at service temperatures. Examples are given for calculating phase boundaries in Cr–Fe, Mo–W, Nb–Ta, and Cr–Mo alloys. (M.C.G.)

33604 THE MÖSSBAUER EFFECT AND ITS APPLICATION IN CHEMISTRY. V. I. Gol'danskii. Authorized Translation from the Russian. New York, Consultants Bureau, 1964. 124p. $12.50.

Information is included on: resonance fluorescence; the Mössbauer effect; shift and splitting of Mössbauer spectrum lines; general reasons it is possible to apply the Mössbauer effect in chemistry; Mössbauer effect in iron and tin compounds; and prospects for using Mössbauer effect in chemistry. A supplement on new results of using the Mössbauer effect in chemistry is given along with 140 references. The use of nuclear quadrupole resonance in chemical crystallography (reprinted from Journal of Structural Chemistry, Vol. 1, Nos 1 and 2) is also included. (P.C.H.)

33605 POSITRON ANNIHILATION IN DIVALENT METALLIC OXIDES. J. H. Kusmiss, J. B. Shand, J. J. Donaghy, and A. T. Stewart (Univ. of North Carolina, Chapel Hill). 9p. (CONF-452-27)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

Measurements were made on the two-gamma angular correlation arising from positron annihilation in three divalent metallic oxides: MgO, ZnO, and CaO. It was concluded that either the polarization by the positron of the electron cloud surrounding the negative ion is more for O^{2-} than for F^- or, the O^{2-} ion in a solid is larger than the calculated wave functions suggest. On the basis of the results, it is suggested that the O^{2-} ion in a solid is slightly larger than has been calculated. (P.C.H.)

33606 PROCESS FOR THE PREPARATION OF URANIUM OXYFLUORIDE AND OXIDES OF URANIUM THEREFROM. (to W. R. Grace & Co.). British Patent 962,779. July 1, 1964. Priority date Dec. 18, 1961, United States.

A process, which economically converts the hexafluoride of uranium into a fine oxyfluoride or oxide powder of desired particle diameter without grinding, and produces a dioxide that, when compacted, will readily densify from 90 to 99% of the crystal density of the dioxide, is described. Using only steam, hydrogen, and air as raw materials, the process allows the permissible U-235 content in the apparatus to be increased without danger of a nuclear reaction. (L.B.S.)

33607 PROCESS FOR THE ELECTROLYTIC PRODUCTION OF URANIUM DIOXIDE CRYSTALS. (to Reactor Centrum Nederland). British Patent 964,227. July 22, 1964. Priority date Mar. 1, 1962, Netherlands.

A process is given for the electrolytic production of very dense UO_2 crystals from a solution of UO_2Cl_2 in a molten salt mixture at relatively low temperatures. The process comprises reacting impure UO_2 or U_3O_8 with a mixture of HCl and O_2 gases at 500 to 600°C in a molten salt, and electrolyzing the formed UO_2Cl_2 at the same temperature. The process can be carried out in glass vessels and may be used to purify irradiated UO_2 fuel elements. The molten salt may be a LiCl–KCl or NaCl–KCl–$MgCl_2$ eutectic. Several examples of the process are given. (D.L.C.)

33608 PREPARATION OF URANIUM AND THORIUM OXIDE SOLS. (to W. R. Grace & Co.). British Patent 965,692. Aug. 6, 1964. Priority date May 12, 1960, United States.

A process is given for preparing UO_2 and ThO_2 sols for use as fuel in homogeneous reactors. The process comprises heating an aqueous solution of a soluble U or Th salt in the presence of excess urea to effect complete hydrolysis to the oxide. The hydrolysis is carried out under reflux at the boiling point if a Th salt is used and at ≥75°C with agitation if a U salt is used, and the urea is added incrementally if the pH of the solution is above 2. The resulting sol is treated, either by ion exchange or flocculation and redispersion, to remove electrolytes. The final sol should have a specific conductance of 10^{-6} to 10^{-2} mhos/cm and can be coated with silica to improve its hydrothermal stability. Several examples of the preparation of such sols are given. (D.L.C.)

33609 IMPROVEMENTS IN OR RELATING TO SOLS OF URANIA, PLUTONIA AND THORIA. (to W. R. Grace & Co.). British Patent 965,693. Aug. 6, 1964. Priority date May 2, 1960, United States.

Hydrothermally stable sols of ThO_2, UO_2, and PuO_2 are described which comprise aqueous dispersions of uniform spheroidal particles with a weight median diameter of 30 to 200 mμ, a cladding layer of ZrO_2, TiO_2, or SiO_2, and a negative charge. The sols also contain sufficient base for a pH of 7.0 to 11.0 but is otherwise electrolyte-free. Such sols may be produced by rapidly mixing the 5 to 10% parent sol with a freshly prepared 1 to 2% sol of the cladding oxide particles of micelle size <5 mμ without allowing the mixture to remain at the isoelectric point for an appreciable time, and then adding the base. The parent sol is previously prepared by gradually removing anions from a solution of a soluble salt at ≥70°C. Several examples of the preparation of ZrO_2-clad ThO_2 sols are given. (D.L.C.)

33610 METHOD OF TREATING EXHAUST GASES WITH URANIA-CONTAINING CATALYSTS. Lawrence J. E. Hofer and Robert B. Anderson (to Dept. of Interior). U. S. Patent 3,140,148. July 7, 1964. Filed July 26, 1961.

A method of oxidizing combustible constituents of internal combustion engine exhaust gases is described that uses U_3O_8 (depleted) on a carrier of Al_2O_3. The gases from the exhaust manifold are passed, together with extra oxygen, over the U_3O_8 with a promoter of ferric oxide, chromic oxide, and/or copper oxide. Examples are given. (R.E.U.)

33611 PROCESS FOR PREPARATION OF URANIUM METAL. J. H. Trapp (to U. S. Atomic Energy Commission). U. S. Patent 3,140,171. July 7, 1964.

An improvement in the process for preparing metal by reduction of UF_4 with Mg is described. At least 25 g of metallic Li in an amassed state is provided within the interior of the reaction mixture. The Li initiates the metal-producing reaction and thus shortens the firing time. Higher firing temperatures (over 1400°F) may be used without affecting metal yield or quality. (AEC)

Organic Chemistry

33612 (BNL-8066) THEORETICAL CALCULATIONS OF KINETIC ISOTOPE EFFECTS FOR SOME NUCLEOPHILIC SUBSTITUTIONS OF METHYL IODIDE. A. V. Willi and Max Wolfsberg (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT-30-2-GEN-16. 8p. (CONF-571-4)

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

Theoretical calculations were made within the transition state framework for the H–D and ^{12}C–^{13}C isotope effects in the exchange reaction of CH_3I with labeled iodide ion and the solvolysis of CH_3I in water. The calculation of the vibrational frequencies is discussed, and these frequencies are tabulated together with the calculated isotope effects k_H/k_D and k_{12}/k_{13}. (D.L.C.)

33613 THE IMPORTANCE OF SOLVATION OF CHARGE GROUPS IN ORGANIC COMPOUNDS AND SUBSTITUENT EFFECTS ON CHEMICAL EQUILIBRIA AND RATE. A. V. Willi (Brookhaven National Lab., Upton, N. Y.). Chimia (Aarau), 18: 107-10(Mar. 1964). (BNL-7776) (In German)

Results presently available on the substituent effects in organic compounds on the chemical equilibrium and the reaction rate are discussed collectively. Some conclusions on the substituent effects in aromatic systems are derived. The substituent groups considered are $-NH_3^+$, $-N(CH_3)_3^+$, $N(CH_3)_2H^+$, m-Cl, p-Cl, m-NO_2, p-NO_2, and p-CH_3. The aromatic compounds on which data are available include acetic acid, aniline, benzene, methanol, and dimethylaniline. (J.S.R.)

33614 THE PREPARATION AND PROPERTIES OF I^{131}-LABELED IODOBENZOIC ACIDS. M. Tubis, J. S. Endow, and S. S. Rawalay (Univ. of California, Los Angeles). Intern. J. Appl. Radiation Isotopes, 15: 397-400(July 1964).

Methods are described for the preparation of ^{131}I-labeled ortho, meta, and para iodobenzoic acids by exchange. These are suitable for biological and other uses. Their toxicity and chromatographic behavior are reported. A possible explanation is offered for the difference in the exchange of ^{131}I for ^{127}I in the formation of these isomers. (auth)

33615 QUADRUPOLE RELAXATION IN NITROGEN NUCLEAR RESONANCES. D. Herbison-Evans and R. E. Richards (Physical Chemical Lab., Oxford). Mol. Phys., 7: 515-26(1963-64).

The ^{14}N resonance line-widths were measured for a wide range of nitrogen compounds. The variation of line-width with viscosity of MeCN, EtCN, PrCN, and Me_2NCHO in various solvents is discussed in terms of the theories of molecular correlation times. The values of the line-widths in substituted nitrobenzenes are discussed in terms of the quadrupole coupling constants. The relative line-widths in the azide ion are discussed in terms of its electronic structure. (auth)

33616 HYDROCARBON MODERATOR-COOLANTS FOR NUCLEAR REACTORS. (to Esso Research and Engineering Co.). British Patent 964,559. July 22, 1964. Priority date, July 14, 1961, United States.

A method is given for increasing the stability of the aromatic catalytic cycle stock extract, an inexpensive distillate refinery by-product. The method comprises pyrolyzing the extract at 500 to 1100°F for 0.5 to 72 hr, and recovering the distillate product in the boiling range 600 to 1100°F. The resulting product has a thermal decomposition rate at 600 to 750°F similar to that of terphenyls. (D.L.C.)

Radiation Chemistry and Radiochemistry

Refer also to abstract 34012.

33617 (AECL-1915) THE RADIATION-DECOMPOSITION CHARACTERISTICS AND PHYSICAL PROPERTIES OF THREE LOW-MELTING ORGANIC COOLANTS FOR REACTORS. M. Tomlinson, M. G. Bailey, and R. R. Tymko (Atomic Energy of Canada Ltd. Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). Apr. 1964. 41p.

The radiation-decomposition, high-boiler production, gas evolution, and other characteristics of a near-eutectic mixture of diphenyl with o- and m-terphenyl, and of two partly hydrogenated terphenyl mixtures, all three liquid at or below 40°C, were surveyed and compared with the behavior of a reference terphenyl mixture. The method was by sealed capsule irradiations at 300 to 400°C and up to 14 Whg^{-1} absorbed dose in a fast neutron enhanced facility in the NRX reactor. Pyrolysis rates at 375 to 475°C were also examined. The vapor pressures, densities, viscosities, melting characteristics, and rates of deposition on heat-transfer surfaces were assessed, for larger quantities of materials irradiated in a loop facility in NRX, and for the starting materials. The hydrogenated mixtures were slightly less stable than the unhydrogenated mixtures under irradiation and produced about ten times as much gas, but they gave a lower proportion of high-boiling products. Thermal decomposition of the hydrogenated mixtures was about ten times faster than for the others. In general, the physical properties of the mixtures were similar. (auth)

33618 (CONF-322-14) THE RADIOLYSIS OF METHANOL AND METHANOLIC SOLUTIONS. III. THE EFFECT OF OXYGEN ON THE RADIOLYSIS OF LIQUID METHANOL BY ^{60}Co γ RAYS AND BY $^{10}B(n,\alpha)^7Li$ RECOILS. Sang Up Choi and Norman N. Lichtin (Boston Univ.). [1964]. Contract [AT(30-1)-2383]. 37p.

From American Chemical Society, Production Technology of Np 237 and Pu 238, Denver, Jan. 1964.

Vapor phase chromatography was used to determine yields of gaseous products. Yields of products per 100 ev absorbed obtained by gamma radiolysis in vacuo are: H_2, 5.0; CH_4, 0.43; C_2H_6, 0.006; C_2H_4, 0.004; CO, 0.06; CH_2O, 2.2; $(CH_2OH)_2$, 3.2. Yields per 100 ev obtained by recoil radiolysis in vacuo are: H_2, 5.5; CH_4, 0.66; C_2H_6, 0.04; C_2H_4, 0.04; CO, 1.0; CH_2O, 3.0; $(CH_2OH)_2$, 0.87. In the presence of O_2, $G(H_2)$, $G(CH_2OH)_2$ and $G(CH_4)$ decrease, while $G(CH_2O)$ increases. Products formed in the presence of O_2 but not in its absence include CO_2, HCO_2H, H_2O_2, and probably CH_3OOH. G(CO) from gamma radiolysis is increased by O_2 but is decreased in the case of recoil radiolysis. Limiting yields of products are obtained at concentrations of O_2 of the order of 1×10^{-3} mole l^{-1} or less. Important limiting yields per 100 ev from gamma radiolysis include: H_2, 1.9; CH_4, 0.18; CO, 0.09; peroxide, 3.1; CH_2O, 8.7; $(CH_2OH)_2$, 0.1; HCO_2H, ca. 1.5. Important limiting yields per 100 ev from recoil radiolysis include: H_2, 2.4; CH_4, 0.6; CO, 0.8; peroxide, 1.5; CH_2O, 3.9; $(CH_2OH)_2$, 0.4; and HCO_2H, ca. 1.0. The gamma radiolysis data are consistent with a mechanism which assumes that only molecular products in unreactive states and free radicals diffuse into bulk solution from the spurs and which does not involve chain autoxidation of methanol. Radical and "molecular" yields relating to the proposed mechanism can be estimated. In contrast, the recoil radiolysis data cannot be explained entirely in terms of free radicals and unreactive molecular products. It appears necessary to assume that metastable excited methanol molecules also diffuse into bulk solution. The various relevant "molecular" and radical yields can also be estimated for recoil radiolysis. (auth)

33619 (MITNE-48) RELATIVE ROLES OF PYROLYSIS AND RADIOLYSIS IN THE DEGRADATION OF TERPHENYLS. Jean-Francois Terrien and Edward A. Mason (Massachusetts Inst. of Tech., Cambridge). June 1964. Contract AT(38-1)-334. 139p. (SRO-87)

An evaluation of recent radiolysis and pyrolysis studies with terphenyl coolants for nuclear reactors indicates that the rate of pyrolysis of irradiated coolant is significantly greater than that of unirradiated coolant and that a consistent correlation of the total degradation yields from a large number of the previous experiments is realized by treating the effects of radiolysis and pyrolysis as additive in the following manner: $-dC_i = k_{R,i}C_i d\tau + k_{pr,i}C_i dt$; $G^*(-i) = [G(-i)/C_i] = G^*_R(-i) + G^*_{pr}(-i)$; where $G^*_R(-i) = 0.26 + 0.01$ molecules of component i degraded by radiolysis alone/(100 ev radiations absorbed) (weight % of component i) and $k_{pr,i}$ = pyrolytic constant of irradiated component i (hr^{-1}). Values of $k_{pr,i}$ are reported for terphenyl coolants over the temperature range from about 400°F (200°C) to 800°F (425°C). Comparison of the results of the loop experiments on this basis indicates that the rate of fast neutron degradation to gamma ray degradation per unit of energy absorbed $G^*_N(-i)/G^*_\gamma(-i)$ (a measure of the "fast neutron effect") is not significantly different from unity. The G values reported for electron irradiations of encapsulated samples are lower than those reported from gamma irradiations; it is suggested that the electron values reported are low because of incomplete mixing during irradiation. Evaluation of the results of capsule irradiations in reactors using the G values obtained from gamma (not electron) irradiations and first-order kinetics gives values of $G^*_N(-i)/G^*_\gamma(-i)$ of between 1 and a high of 2.4. The activation energy for the radiolysis process ΔE_R appears to be low (values obtained range from 0 to about 2 kcal/mole, but insufficient data are available to establish the magnitude of ΔE_R with confidence). (auth)

33620 (NP-14187) UN METODO DE PRODUCCIÓN DE IODO-131 A PARTIR DE OXIDOS DE URANIO IRRADIADOS. Informe No. 101. (Method for Production of ^{131}I From Irradiated Uranium Oxides. Report No. 101). S. Abrashkin and R. Radicella (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). 1963. 11p.

A procedure to obtain fission product ^{131}I by "dry distillation" from uranium oxides is described. The distillation of ^{131}I from UO_2 and UO_3 at different temperatures was studied and a yield of 75% was found by heating amorphous UO_3 for 10 hours in air at 700°C. In order to avoid ruthenium contamination, the gases from the distillation were passed through iron chips heated at 700°C and a quantitative retention of ruthenium was observed. The radioactive purity of the ^{131}I preparation was greater than 99.9 per cent. (auth)

33621 (UJV-977/64) ÚČINKY IONISAČNÍHO ZÁŘENÍ NA EXTRAHOVADLA-KETONY. II. ČÁST. (Effects of Ionizing Radiation on Ketone Extraction. Part II). J. Teplý, M. Teichmanová, B. Bartoníček, I. Janovský, J. Kříž, and J. Moravec (Československá Akademie Věd. Ústav Jaderného Výzkumu, Řež). [1962]. 31p.

Experimental data of radiolysis of methyl isobutylketone (MIK) and methyl cyclohexanone (MCH), of their solutions with uranyl nitrate and two-phase systems with water mostly in the presence of air have been obtained. The consumption of molecular oxygen in these ketones was measured: $G(-O_2)$ is 14 and 31 for MIK and MCH respectively; the influence of water and of uranyl nitrate concentration on these values has been determined. The production of peroxidic substances has been observed: in pure ketones $G(ox.eq.)_{in.}$ is 10 for MIK and 3 for MCH. This yield increases with the increase of uranyl nitrate concentration up to a certain limit, and the stationary concentration of peroxidic substances increases, too. The yield of acid products is 0.4 and 0.1 in MIK and MCH respectively; similarly $G(CO_2)$ is 0.7 and 0.1. The peroxidic substances are not produced in de-aerated ketones. In de-aerated solutions of uranyl nitrate after a considerable induction period the partial reduction of U(VI) to U(IV) occurs. The non-reextractibility of U(VI) was measured in dependence on the dose: the non-reextractible remnant amounts to few hundreths of per cent of the original concentration of U(VI). The separation rate of the organic and water phases has been determined in dependence on the dose also in presence of nitric acid, aluminum nitrate, and uranyl nitrate. Some features of reaction mechanism of radiolytic processes have been considered. In the conclusion, the studied ketones are compared from the point of view of their radiation resistance; MIK appears to be more favorable. (auth)

33622 EFFECTS OF POLARIZATION IN DIELECTRICS IRRADIATED WITH X RAYS. Emil Luca, N. Reus, and Gh. Tacu (Politechnic Inst., Jassy). Bul. Inst. Politeh. Iasi, 9: 223-30(1963). (In Romanian)

Polarization and depolarization curves were traced for an x irradiated mixture of 95% sulfur and 5% paraffin as a function of the feed voltage of the x-ray tube (or the wave length of the beam), of the electron current of the tube (or the number of photons occurring in the x-ray beam), and of the length of irradiation. It was established that mixtures of sulfur and paraffin have the same type of photoelectric properties as sulfur in the pure state after x irradiation. The analysis of the shape of the depolarization curves as a function irradiation time shows that electrets obtained from these mixtures have a better stability than those of sulfur. (tr-auth)

33623 RADIOLYSIS OF CYCLOHEXANONE. I. PURE LIQUID. Ajit Singh and Gordon R. Freeman (Univ. of Alberta, Edmonton). Can. J. Chem., 42: 1869-76(Aug. 1964).

The G values of the major products of the gamma radiolysis of liquid cyclohexanone were found to be hydrogen (0.76), carbon monoxide (0.45), 1-pentene (0.22), 5-hexenal (0.85), cyclohexenone (0.4), cyclohexanol (0.5), dimer (1.15), and polymer (1.8 cyclohexanone units). A large number of minor products were also measured. The amount of ring cleavage that occurs in cyclohexanone was much greater than occurs in the radiolysis of cyclohexane. The increase was attributed to the influence of the carbonyl group on the course of the reaction. Ring cleavage occurs preferentially at the C—C bonds to the carbonyl group. Much of the radiolytic reaction appears to occur from energy states higher than those of importance in the photolytic studies. (auth)

33624 RADIOLYSIS OF CYCLOHEXANONE. II. EFFECT OF SOLUTES ON PRODUCTS INVOLVING C—H BOND RUPTURE. Ajit Singh and Gordon R. Freeman (Univ. of Alberta, Edmonton). Can. J. Chem., 42: 1877-89(Aug. 1964).

Some of the products whose formation, during the radiolysis of cyclohexanone, involves the rupture of C—H bonds are hydrogen, cyclohexanol, 2,2'-diketodicyclohexyl, and probably other dimers of cyclohexanone. Benzene appears to inhibit the formation of hydrogen mainly by an activation transfer process. The influence of 2,3-dimethyl-1,3-butadiene (DMB) on the hydrogen yield is more complex and probably involves more than one inhibition reaction. Less than one mole percent of DMB or of oxygen inhibits the formation of cyclohexanol and of dimers to below their limits of detection on the analytical system ($G < 0.2$). This is probably due to the scavenging of free radicals ($G(\text{scavengeable radicals}) \approx 4$). Benzene is much less efficient than DMB or oxygen in inhibiting the formation of cyclohexanol and of dimers of cyclohexanone. (auth)

33625 EFFECTS OF CHLORINE AND BROMINE ON THE RADIOLYSIS OF GASEOUS HCl. R. A. Lee, R. S. Davidow, and D. A. Armstrong (Univ. of Alberta, Calgary). Can. J. Chem., 42: 1906-16(Aug. 1964).

Using an ionization chamber method, it was found that the energy required to create an ion pair in gaseous HCl, W_{HCl}, is 24.4 ± 0.6 ev. The hydrogen yield, $G(H_2)_{HCl\ gas\ at\ 23°C} = 8.0 \pm 0.3$, was independent of HCl pressure in the range 19 to 119 cm of Hg. The effects of added bromine demonstrated that at least two species are involved in hydrogen formation, and there are strong indications that one of these is an electron. A second species, designated as ^{11}H and formed with a yield $Gu_H = 2.5$, is not readily scavenged by bromine. The use of chlorine as a scavenger also provided evidence for the presence of more than one hydrogen-forming species. The data of an earlier study of the α-particle radiolysis were corrected for back reactions of the chlorine which accumulated in the system. (auth)

33626 FRACTIONATION OF GERMANIUM ISOTOPES IN CHEMICAL REACTIONS. H. M. Brown and H. R. Krouse (Univ. of Alberta, Edmonton). Can. J. Chem., 42: 1971-8(Aug. 1964).

Isotopic vibrational frequencies and the corresponding partition-function ratios for several compounds containing ^{70}Ge and ^{76}Ge were calculated at various temperatures. The theoretical equilibrium constants for germanium isotope-exchange reactions derived from these partition-function ratios indicate that noticeable germanium isotope fractionation might be effected with laboratory reactions. Calculated kinetic isotope effects in the breaking of diatomic bonds also predict observable alterations of the $^{70}Ge/^{76}Ge$ ratio. A kinetic isotope effect of 1.0% observed in the chemical reduction of GeO_2 to GeO is discussed. (auth)

33627 AN ELECTRON IMPACT STUDY OF METHYL PHENYL ETHERS. F. Meyer and A. G. Harrison (Univ. of Toronto). Can. J. Chem., 42: 2008-17(Aug. 1964).

The mass spectra of anisole, anisole-methoxy-$\underline{d}_3$, meta and para methylanisole, meta and para methyl-$\underline{d}_3$-anisole, and meta and para methylanisole-methoxy-$\underline{d}_3$ were recorded. From deuterium labeling and appearance potential studies, the main fragmentation paths on electron impact were elucidated. The energetics of formation of the $CH_3OC_7H_6^+$ ion from the methylanisoles, benzyl methyl ether, 7-methoxycycloheptatriene, and the ethylanisoles were studied. (auth)

33628 THE FORMATION OF TRIBUTYLIODOAMMONIUM IODIDE IN THE URANYL PHOTOSENSITIZED REACTION WITH TETRABUTYLAMMONIUM IODIDE. J. K. S. Wan, E. A. Schuck, J. K. Foote, and J. N. Pitts, Jr. (Univ. of California, Riverside). Can. J. Chem., 42: 2029-31(Aug. 1964).

A photochemical method for the preparation of tributyliodoammonium iodide by the reaction of tetrabutylammonium iodide in aqueous solution sensitized by uranyl nitrate is reported. The product exists at room temperature as a black powder with a melting point of 65—68°C. The compound is stable at least up to 135°C, and exhibits a reversible thermochromic phenomenon (from black to yellow) when warmed to 88°C or higher. The experimental data are sufficient to establish the entire reaction mechanism, but seem to suggest that oxidation of the iodide ion is sensitized by the photoexcited uranyl ions, leading to an iodine atom and a solvated electron. (P.C.H.)

33629 DIRECT TRANSFORMATION OF NUCLEAR ENERGY INTO CHEMICAL ENERGY. U. Schindewolf (Technische Hochschule, Karlsruhe, Ger.). Chem. Ing. Tech., 36: 15-23(1964). (KFK-208). (In German)

The principles of chemonuclear processes are reviewed. The technological possibilities and economic considerations in the radiochemical synthesis of glycol from methanol and nitrogen oxides from air are discussed. (tr-auth)

33630 ELECTRON SPIN RESONANCE SPECTRA OF ORIENTED RADICALS. J. R. Morton (National Research Council, Ottawa). Chem. Rev., 64: 453-71(Aug. 1964).

The electron spin resonance spectra of oriented radicals trapped in single crystals are discussed. Data on the electron spin resonance of radiation-damaged organic crystals, mostly the dicarboxylic and amino acids, are reviewed. Paramagnetic fragments trapped by doping or radiation processes in inorganic crystals are also considered. The theory of electron spin resonance and methods of its measurement are outlined. The electron-nuclear hyperfine interaction is described. With the exception of a short discussion on oriented triplet-state radicals, attention was confined to doublet systems. (134 references) (M.C.G.)

33631 SNYTHESIS OF LABELED ORGANIC COMPOUNDS. H. L. Otto. Chem. Weekblad, 60: 58-68(1964).

Labeled organic compounds are mainly obtained by methods well-known in synthetical organic chemistry. Special features, however, justify a separate consideration. Considerations preceding a synthesis are related to the choice of the radioisotopes and the place in the molecules, the specific activity and quantity, specific labeling, the availability of labeled molecules, and the choice of synthesis. Some special techniques are used, especially for the syn-

thesis of labeled molecules of high specific activity. The determination of the radiochemical purity of the labeled compounds and the problems connected with the storage of these compounds are described. A survey is given of the research at the Radioisotope Department of the Central Laboratory of TNO. (auth)

33632 ABSORPTION AND THERMOSTIMULATED ELECTRON EMISSION AND LUMINESCENCE OF LiF CRYSTALS BOMBARDED WITH ALPHA PARTICLES. A. Bohun (Inst. of Solid State Physics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 14: 322-7(1964).

The results of measurements of absorption and thermostimulated electron emission and luminescence in the same kind of LiF crystals irradiated with x rays and alpha particles are presented. The different method of excitation has the consequence that the curves of the three phenomena are to a certain extent different. The possible causes of these differences are discussed. (auth)

33633 CONTRIBUTION OF BETA AND GAMMA RADIATION ACTIVITY TO TOTAL DOSE INTENSITY OF FISSION PRODUCTS. V. Hádek and M. Kulka. Czech. J. Phys., 14: 411-16(1964).

A numerical analysis shows the contribution of beta and gamma radiation to the total dose intensity of fission products. The problem was solved for the case of an infinite plane covered with an ideally thin layer of isotope and for two different cases of absorption layers (86 and 650 mg/cm^2) above this plane. The different ages of the fission products were also considered. It was found that the beta radiation contribution to the total dose intensity predominates strongly in the case of the 86 mg/cm^2 absorption layer, for the 650 mg/cm^2 absorption layer it is comparable with the dose intensity of gamma radiation. (auth)

33634 PHOTOCHEMICAL REACTIONS. REPORT 28. UV-IRRADIATION OF 11-OXO-STEROIDS. IV. 3,20-DIETHYLENEDIOXY-11-OXO-C-NOR-5α-PREGNANE. J. Iriarte, K. Schaffner, and O. Jeger (Eidgenossische Technische Hochschule, Zurich). Helv. Chim. Acta, 47: 1255-64(1964). (In German)

In contrast to the light-induced formation of 11,19-t-cyclobutanol derivatives from 11-oxo-pregnanes, the saturated 11-oxo-C-nor-pregnane is converted rapidly and quantitatively into the unsaturated aldehyde upon ultraviolet irradiation in solution. The isomerization is independent of the nature of the solvent and is largely unaffected by the presence of molecular oxygen. (auth)

33635 PHOTOCHEMICAL REACTIONS. REPORT 29. MECHANISM OF PHOTOCHEMICAL REARRANGEMENT OF 3-OXO-4,5-OXIDO-STEROIDS. H. Wehrli, C. Lehmann, K. Schaffner, and O. Jeger (Eidgenossische Technische Hochschule, Zurich). Helv. Chim. Acta, 47: 1336-40(1964). (In German)

3-Oxo-4,5-oxido-10β-steroids have previously been shown to rearrange photolytically to the corresponding 3,5-dioxo-10(5 → 4)-abeo compounds. It was found that the 10α-testosterone oxide gives specifically a 10α-product and the stereoisomeric 4-methyl-testosterone oxides undergo stereospecific rearrangements. (auth)

33636 THE SCINTILLATION PROCESS IN ALKALI HALIDE CRYSTALS. J. B. Birks (Univ. of Manchester, Eng.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 4-11(June 1964).

The scintillation process in impurity-activated alkali halide crystals is considered by analogy to that in binary solid organic solutions. A general relation is proposed for the differential scintillation efficiency dL/dE as the product of the efficiencies of the primary and secondary scintillation processes. The primary efficiency is influenced by electron-hole recombination and ionization quenching and is a function of the specific energy loss dE/dr. The secondary efficiency is influenced by host-activator energy transfer and concentration quenching and is a function of the activator concentration. Experimental data in support of the model are cited. An extension of the model is proposed to account for the temperature dependence of the scintillation efficiencies and decay times of pure and impurity-activated alkali halides, and this is compared with experimental data. (auth)

33637 IMPROVED FLUORESCENCE DECAY-TIME MEASURING APPARATUS. I. B. Berlman and O. J. Steingraber (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 27-8(June 1964).

An apparatus was assembled which is capable of detecting and reproducing the fluorescence pulse contours from scintillation materials. The recent modifications in the apparatus and the presentation of preliminary data are emphasized. A comparison is made between the fluorescence decay time of ordinary and deuterated compounds. Also preliminary results indicate that in a series of similar type molecules each with a high quantum yield, the longer the molecule the shorter the fluorescence decay time. (auth)

33638 RELATIVE LIGHT OUTPUT EVALUATION OF DIFFERENT COMMERCIAL PLASTIC SCINTILLATORS. W. C. Kaiser (Argonne National Lab.) and J. A. M. de Villiers. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 29-37(June 1964).

An evaluation of light emitted from commercial plastic scintillators, when bombarded with radioactive particles, was done using photomultiplier tubes with S-11 and S-13 responses. Fourteen plastic scintillators were compared and eight different kinds were used to study light output as a function of length. It was found that light output does not fall exponentially with increasing length but rather as the sum of two exponents. A proposed method of analysis leads to two different absorption coefficients. Two possible explanations are given for this phenomenon. (auth)

33639 PROTON-TRANSFER REACTIONS BETWEEN H_3^+ AND SATURATED HYDROCARBONS. P. Ausloos and S. G. Lias (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 40: 3599-3605(June 15, 1964).

The γ radiolysis of H_2 was investigated in the presence of relatively small concentrations of C_2D_6, C_3D_8, iso-C_4H_{10}, $(CH_3)_3CD$, $(CD_3)_4C$, and n-C_5D_{12}. It is shown that, in all cases, the proton-transfer reaction $H_3^+ + RD \rightarrow RDH^+ + H_2$, occurs even when the additive is only 0.01% of the hydrogen. The protonated hydrocarbon decomposes mainly to form a carbonium ion and an neutral alkane molecule. From the radiolysis of $D_2-CH_4-C_3D_8$ mixtures, it could be deduced that CH_4D^+ is produced, which subsequently transfers a proton or deuteron to C_3D_8. It is suggested that the study of the radiolysis of H_2, in the presence of additives offers the possibility of producing well-specified ions, the reactions of which can be followed in the absence of interfering processes. (auth)

33640 STERIC EFFECT IN HOT HYDROGEN DISPLACEMENT REACTION WITH ISOBUTANE. Allan Odell,

Allan Rosenberg, Richard D. Fink, and Richard Wolfgang (Yale Univ., New Haven). J. Chem. Phys., 40: 3730-1 (June 15, 1964). (NYO-1957-37)

Results on the relative efficiency of hydrogen displacement in isobutane are presented. Consistent results were found for the variety of separate scavengers used for thermal species. No pressure dependence for the reaction was found indicating that decomposition of excited isobutane-T formed by displacement does not distort results. Tertiary hydrogen displacement in isobutane was found to be reduced by 21% relative to displacement of any primary C-H bond. The postulate of steric obstruction to hydrogen displacement in hydrocarbons is thus supported. (P.C.H.)

33641 ELECTRON SPIN RESONANCE AND MOLECULAR MOTION OF THE $RCH_2\dot{C}HCOOR'$ RADICALS IN X-IRRADIATED ESTER-UREA INCLUSION COMPOUNDS. O. Hayes Griffith (California Inst. of Tech., Pasadena). J. Chem. Phys., 41: 1093-1105(Aug. 15, 1964).

Single crystals of the inclusion compounds formed between long-chain alkyl esters and urea were x irradiated at room temperature, and the free radicals produced were investigated by electron spin resonance. The 11 esters studied were diethyl adipate and the methyl, ethyl, hexyl, and octyl esters of monocarboxylic acids. The long-lived free radicals observed in all of these compounds are of the type $RCH_2\dot{C}HCOOR'$. These are π-electron radicals with the unpaired electron largely localized on one carbon 2p orbital. The coupling constants of the alcohol protons (R') were resolved in the spectra of several radicals and the values ranged from 3 to 6 Mc/sec. The ester radicals undergo motion in the tubular cavities formed by the urea molecules of the crystal, and this affects the magnitudes of the proton coupling constants. The dependence of the α- and β-proton coupling constants on this motion is briefly considered. From the ethyl heptanoate radical ESR data, recorded over the range of 352 to 7 ± 3°K, and from the room-temperature ESR data of all eleven ester radicals, information is obtained regarding the motions and orientations of the ester radicals. In addition, two carboxylic-acid-urea inclusion compounds were investigated, and the orientations and motions of the well-known radicals produced in these systems ($RCH_2\dot{C}HCOOH$) are compared to those of the ester radicals. Approximate equations are given that relate the observed α-proton coupling constants and spectroscopic splitting factors to the diagonal elements of the α-proton tensors and g tensors of all radicals investigated. (auth)

33642 EFFECT OF ELECTRICAL FIELDS IN THE GAMMA RADIOLYSIS OF PROPANE. P. Ausloos and R. Gorden, Jr. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 41: 1278-84(Sept. 1, 1964).

The γ radiolysis of C_3H_8-C_3D_8 mixtures and of $CD_3CH_2CD_3$ was investigated as a function of applied electrical field up to voltages necessary to cause secondary ionization. In the saturation current region, those products that were previously ascribed to ethyl and vinyl ions remain constant with a change in field strength, while products that were originally attributed to the decomposition of neutral excited propane molecules were found to increase about fivefold before the onset of secondary ionization. The inferred yields of $C_2H_5^+$ and $C_2H_3^+$ per ion pair at a propane pressure of 3 cm are 0.40 and 0.08, respectively. These values compare favorably with those deduced from the fragmentation of propane within 10^{-10} sec as calculated by others on the basis of the quasiequilibrium theory of mass spectra. The modes of decomposition of the neutral excited propane molecules formed by electron impact were the same as those observed in the vacuum-ultraviolet photolysis at 1470 and 1237 Å. From the isotopic analysis of the products formed in the radiolysis of $CD_3CH_2CD_3$ at high field strengths, it was concluded that the average energy imparted to the neutral propane molecule by electron impact is larger than 10 ev, indicating that superexcited states of propane may be produced in the radiolysis. A value of 0.3 ± 0.1 can be ascribed to the ratio of the number of neutral excited molecule decompositions to the number of ion pairs produced in the direct radiolysis of propane in the absence of an electrical field. (auth)

33643 CRYSTAL GROWTH AND COLOR CENTERS OF ALKALINE-EARTH HALIDES. Francis K. Fong and P. Niel Yocom (RCA Labs., Princeton, N. J.). J. Chem. Phys., 41: 1383-8(Sept. 1, 1964).

Single crystals of CaF_2, $SrCl_2$, $BaBr_2$, and BaClF were grown. Color centers were developed in calcium fluoride by treatment with Ca vapor at 850°C and by gamma irradiation at room temperature. It was observed that additive colorability of the salt depends on the rate of cooling from the additive-coloring temperature. The gamma-irradiated samples display a host of color centers, the formation of which appears to be dependent upon the dosage of the irradiation. Below 10^5 rad, no coloration of the crystal was achieved by irradiation. At higher dosages, bands due to yttrium and oxygen impurities became evident, whereas at the very high dosage of 5×10^7 rad, a multibanded spectrum with very intense infrared absorption was obtained. These bands are believed to be indicative of the formation of defect centers by high-dosage irradiation. Unlike the bands associated with chemical impurities, these bands were relatively unstable. They were readily bleached by heat and light, the bands in the infrared being the most unstable. Color centers were also observed in strontium chloride, barium bromide, and barium chlorofluoride. Whereas only one band was observed for strontium chloride, more were observed for barium bromide and barium chlorofluoride, which may presumably be due to their noncubic symmetries. Bands produced by gamma irradiation in these crystals were unstable, and all bleached readily under ordinary room conditions. (auth)

33644 SEARCH FOR THE ZEEMAN EFFECT OF A COLOR CENTER IN SODIUM CHLORIDE. M. H. Crozier (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 41: 1510-11(Sept. 1, 1964).

Several alkali halide crystals were colored by γ irradiation and it was found that a particularly sharp line was produced in NaCl after 3 MR. Further irradiation, up to 10 MR, caused the line to broaden and split into two components 0.1 cm apart, presumably due to effects of the high concentration of centers produced. The Zeeman effect of the line at 8373.3 Å was sought at 4.2°K with a photographic spectrograph giving a resolution of at least 0.2 Å, using magnetic fields up to 110 kG applied principally along the (100) direction. No splitting, shift, or broadening of the line could be detected. This was interpreted as conclusive evidence that the center producing the line consists of an even number of electrons, probably an aggergate of an even number of F centers. (P.C.H.)

33645 ON THE g FACTOR OF HYDROGEN ATOMS TRAPPED IN PHOSPHATES. Seiji Ogawa and Richard W. Fessenden (Mellon Inst., Pittsburgh). J. Chem. Phys., 41: 1516-17(Sept. 1, 1964). (RRL-135)

Studies were made on the ESR spectra of hydrogen atoms produced by ionizing radiation and trapped in calcium and sodium phosphate lattices. Measurements were made on the effect of isotopic mass on the g factor for hydrogen

atoms. The values reported are quite normal and the values of the g factor agree with those found for hydrogen atoms trapped at the majority of the types of sites in various rare-gas matrices (2.0016–2.0022) as well as with those reported for hydrogen atoms in frozen, irradiated water-acid mixtures (2.002–2.0024). It was concluded that for the phosphate systems at least, the g factor is close to the free-electron value and that there is no significant shift of g factor upon isotopic substitution. (P.C.H.)

33646 THE UNEXPECTED INCORPORATION OF UNBOUND IODIDE-131 INTO THE NON-RADIOACTIVE HIPPURAN MOLECULE. Thomas A. Hosick, F. Clay Watts, and I. Meschan (Wake Forest Coll., Winston Salem, N. C.). J. Nucl. Med., 5: 551-4(July 1964).

Observations show that if the specific activity of a commercial preparation of iodine-131-labeled Hippuran containing contaminating free radioiodide is lowered by a factor of about 10,000 by dilution with a nonradioactive Hippuran solution, the per cent radioiodide contamination decreases upon standing over a period of time at room temperature in the dark. Furthermore, if sodium iodide-131 and nonradioactive Hippuran solutions are mixed, the per cent radioactivity due to ^{131}I rapidly decreases from the initial 100 per cent. An unknown radioactive compound is formed, presumably organic, which behaves chromatographically very similar to radio-Hippuran. The addition of a solution of sodium diatrizoate to a sodium iodide-131 solution does not result in iodide-131 decrease. Cobalt-60 radiation and ultraviolet light do not appear to change the rate of iodide-131 decrease in solutions containing nonradioactive Hippuran and sodium iodide-131. (auth)

33647 ELECTRON SPIN RESONANCE OF POTASSIUM COLLOIDS IN KN_3. Robert C. McMillan (Army Engineer Research and Development Labs., Fort Belvoir, Va.). J. Phys. Chem. Solids, 25: 773-5(July 1964).

Potassium colloids were formed in irradiated KN_3 by heating to 300°C. A study of the electron spin resonance (esr) of the conduction electrons over the temperature range $100 < T < 450$°K showed that the width is dependent on the electrical resistivity, ρ. The resonance width at maximum slope points, ΔH, is given by: $\Delta H = 10.2 \times 10^{+6}\rho + 35.7$. Since the resistivity changes abruptly at the melting point of K, the esr width should change. This was observed. The theory was used to estimate a particle diameter of 14 Å. The g value was measured as 1.9982 ± 0.0005. (auth)

33648 LOW-TEMPERATURE LUMINESCENCE IN ALKALI HALIDE CRYSTALS UNDER X-RAY IRRADIATION. Shohei Wakita and Masayasu Ueta (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 19: 924-9(June 1964).

Luminescence spectra were photographed at various temperatures down to 4°K in KBr, KCl, and NaCl crystals. Two ultra violet emission bands are found. The higher energy band is strong at 4°K and decreases its intensity with temperature and vanishes at 60°K. The intensity of the lower energy band is weak at 4°K but increases with temperature until 80°K. It is inferred that the higher energy band is attributed to the electron recombination with hole in H center and the lower energy band is emitted by the annihilation of a trapped exciton which is temporarily generated from the electron capturing by a self trapped hole of V_K center. Four emission bands are found at visible region in KCl crystal at 4°K which seem to construct a hydrogenic series. (auth)

33649 NEW INFORMATION ON THE γ-RAY RADIATION-INDUCED POLYMERIZATION OF ETHYLENE. Sueo Machi, Miyuki Hagiwara, Masao Gotoda, and Tsutomu Kagiya (Japan Atomic Energy Research Inst., Takasaki, Japan). J. Polymer Sci., Pt. B, 2: 765-8(Aug. 1964).

An investigation was made on the radioinduced polymerization of ethylene under high pressure. New observations in relation to the induction period, rate of polymerization, and the molecular weight of the polymer are reported. It was found that polymer is formed even in irradiation times of less than 2 hr at a pressure of 400 kg/cm^3. However, no induction period was observed. An acceleration rate was observed in the polymerization since the polymer yield increased rapidly with reaction time. The results clearly demonstrated that the molecular weight of polymer formed is proportional to the reaction time. It was concluded that the stationary state hypothesis, that the rate of initiation is equal to that of termination, is not realized in this polymerization. (P.C.H.)

33650 THE RADIATION-INDUCED POLYMERIZATION-MODIFICATION OF ACRYLONITRILE. C. L. Furrow and C. E. Stoops (Phillips Petroleum Co., Bartlesville, Okla.). J. Polymer Sci., Pt. B, 2: 775-8(Aug. 1964).

Gamma irradiation of an acetone solution of acrylonitrile resulted in the formation of a modified polyacrylonitrile through the addition of acetone across occasional nitrile groups. Modification is favored by increased dilution. As modification increases, the order of property changes is improved dye receptivity, altered infrared spectrum, deepened color, and increased solubility. Also, as modification increases, the definition of the fine structure in the infrared spectrum becomes progressively more distinct. Acetonitrile, methanol, ethanol, and 2-propanol were also evaluated as solvents in 5/1 mole ratio solvent/acrylonitrile solutions. (P.C.H.)

33651 CATALYTIC EFFECT OF INORGANIC SOLID ADDITIVES ON THE RADIATION-INDUCED SOLID STATE POLYMERIZATION OF 3,3-BIS-CHLOROMETHYLCYCLOXABUTANE. Tsutomu Kagiya, Masatsugu Izu, and Kenichi Fukui (Kyoto Univ.). J. Polymer Sci., Pt. B, 2: 779-81(Aug. 1964).

Studies on the catalytic effect of inorganic solid additives on the radioinduced solid state polymerization of 3,3-bischloromethylcycloxabutane showed that BaO and Cs especially had a high activity. Metallic K and Na were also effective catalysts for the polymerization. The infrared spectra and melting point of polymer produced in the presence of additives were identical with those of polymer produced in the absence of additives. The role of the additive is not clear but may be ascribed either to a catalytic effect or to a trapping of a poison produced during irradiation. (P.C.H.)

33652 RADIATION CROSSLINKING OF POLYISOBUTYLENE. George Odian (Columbia Univ., New York) and Bruce S. Bernstein. J. Polymer Sci., Pt. B, 2: 819-21 (Aug. 1964).

The radioinduced crosslinking of polyisobutylene via the use of allyl acrylate is reported. Facile crosslinking was found to occur by the very rapid initial increase in the gel fraction with increasing radiation dose. In the absence of the monomer, polyisobutylene undergoes degradation without crosslinking and a gel fraction is not observed. Allyl methacrylate was found to act similarly to allyl acrylate. (P.C.H.)

33653 A VOLUMETRIC AUTOMATIC DISPENSER OF RADIOACTIVE LIQUID. V. K. Kalina (Kiev Medical Graduate School). Med. Radiol., 9: No. 6, 51-4(June 1964). (In Russian)

An automatic dispenser for radioactive liquids is described. The apparatus enables remotely-controlled automatic-apportioned filling of containers for liquid isotopes, thus averting the possibility of radioactive pollutions and ensuring radiation protection for the personnel. (auth)

33654 MICROSCALE CHEMICAL TECHNIQUES FOR PREPARING α- AND β-SPECTROSCOPY SOURCES. S. Bjoernholm, Else R. Johansen, and H. Nordby (Univ. of Copenhagen). Nucl. Instr. Methods, 27: 243-52(May 1964).

Ion exchange columns with a typical column volume of one microliter are used for the concentration and purification of carrier-free radioisotopes. The effluent active solution from the microcolumn may be directly deposited on source backings consisting of plastic foils with a thickness of about 30 $\mu g/cm^2$. Foils containing polystyrene can be made hydrophilic within a small spot, defining the source area. The experimental techniques are described, and a number of examples are given. (auth)

33655 CHOOSING OPTIMUM COUNTING METHODS AND RADIOTRACERS. S. A. Reynolds (Oak Ridge National Lab., Tenn.). Nucleonics, 22: 104-5(Aug. 1964). (ORNL-P-40)

A method for selecting the optimum technique for measuring a given radionuclide in radiochemical or tracer work or to choose the best radiotracer for a given task is described. The choice depends on the efficiencies and backgrounds of the available instruments in a way that is indicated by the figure of merit. The results of applying this figure-of-merit method to the common radionuclides ^{85}Sr, ^{89}Sr, ^{137}Cs, and ^{144}Ce for a variety of detector arrangements are given. The figures of merit for 100-dpm quantities of each of these nuclides are also given. An example is presented to illustrate the method. (C.E.S.)

33656 RELATION OF CROSSING AND ANTICROSSING EFFECTS IN OPTICAL RESONANCE FLUORESCENCE. K. E. Lassila (Case Inst. of Tech., Cleveland and Ames Lab., Ames, Iowa). Phys. Rev., 135: A1218-19(Aug. 31, 1964). (IS-877)

An interaction hamiltonian analogous to that in a coupled Lee model is used to calculate the transition matrix appropriate for the description of the anticrossing effect in optical resonance fluorescence. The transition matrix is found to contain two terms (in addition to those for resonance scattering through each of the coupled states) which exist in the amplitude only because the damping matrix in the coupled representation is not diagonal. This matrix is diagonal when the uncoupled states have equal radiative widths, and the resonance scattering intensity is then given by the Breit formula. This result justifies the application by Eck, Foldy, and Wieder of the Breit equation to their initial discovery of the anticrossing effect even though this formula would not be expected to apply to the general anticrossing situation. The crossing effect can also be discussed as a special case of the approach presented. (auth)

33657 PARAMAGNETIC RESONANCE OF A FLUORINE CENTER IN X-IRRADIATED F^{19} DOPED BERYLLIUM OXIDE POWDER. Z. Šroubek (Inst. of Radio Engineering and Electronics, Prague), L. Novák, and K. Ždánský. Phys. Status Solidi, 6: 173-8(1964).

Electron spin resonance of x irradiated, fluorine-doped, BeO powder was studied. Two single resonances with g-factors of 2.002 and 2.012, and a characteristic doublet resonance, were observed. The resonance doublet, which has a splitting of (760 ± 5) Oe, is presumed to be due to F^{2-} and is absent in chemically pure BeO powder. The results can be explained on the basis of a model in which the magnetic electron is localized in the 3s orbital of F^- and interacts with the adjacent Be nuclei. The possible environment of the fluorine atoms is discussed. (auth)

33658 RADIOLYSIS OF THYMIDINE. N. P. Krushinskaya and M. I. Shal'nov. Radiobiologiya, 4: 360-6(1964). (In Russian)

Commercial thymidine without additional purification was gamma-irradiated (^{60}Co) in aqueous solutions at concentrations from 10^{-5} to 3×10^{-3} M at a rate of 2.65×10^{14} ev/g·sec (260 rads/min), the absorbed dose varying from 0.5 to 300 krads. The radiochemical yield of the decomposition of the chromophoric groups was shown to vary from 2 to 3.5 molecules per 100 ev in this concentration range. Saturation of the solution with oxygen did not affect the results. In the presence of $Na_2S_2O_8$, the decomposition yield increased to 8 molecules per 100 ev. Some of the radiolysis products were hydrogen peroxide (initial yield 1.6 molecules per 100 ev), organic hydroperoxides (0.5 molecule per 100 ev), and carbonyl compounds (maximum yield 1.1 molecules per 100 ev). The possibility is considered that the reaction mechanism is related to the action of radicals on the nitrogen and carbon parts of the thymidine molecule. Thymidine was studied as a typical representative of the pyrimidine nucleosides that determine the chemical face of one of the four monomers of DNA, and which in the free state plays an important role in nuclear biosynthesis. (TTT)

33659 4π LIQUID SCINTILLATION COUNTER FOR THE ABSOLUTE MEASUREMENT OF THE β ACTIVITY OF PREPARATIONS IN LAYERS; FABRICATION METHOD USED. G. V. Vende and V. P. Parchevskii (Kovalevskii Biological Inst. of Southern Seas, Sebastopol, USSR). Radiobiologiya, 4: 465-7(1964). (In Russian)

A previously described 4π scintillation counter was further perfected. A photomultiplier, fed by a high-voltage rectifier was used as the scintillation detector; the integral pulse-amplitude spectra were obtained by means of a wide-band linear amplifier with internal discrimination. The counter and the photomultiplier were surrounded by a 5-cm Pb shield. A 5 g/l solution of terphenyl in meta-xylene was used as the liquid scintillation medium. A rectangular, 50 × 50 × 30 mm, Ni-plated metal container served as housing, using an emulsion-free photographic film as the bottom covering. Various improvements of the original design made it possible to reuse the same scintillation liquid up to 50 times for measuring the activity of the preparations and to determine simultaneously the decay rates of several specimens. The activity of colored specimens could be determined with an efficiency within 94 to 97%. Use of the instrument was very helpful in attempts to economize on the use of the expensive scintillation materials. (TTT)

33660 HOT ELECTRON CHEMISTRY. A REVIEW OF HOT ATOM CHEMISTRY. G. N. Walton (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Radiochim. Acta, 2: 108-12(Mar. 1964).

Some features of the present position on theories of the chemical effects of nuclear transformation are briefly reviewed. It is suggested that theories based on the transfer of energy by elastic collisions of recoiling atoms are not adequate to explain many of the experimental observations. Instead it is shown that electronic excitation, the transfer of energy between electrons, and the consequent loss of valency bonding or its rearrangement, are likely to

be of primary importance for explaining these effects. (auth)

33661 CHEMICAL STATE OF I^{131} FORMED IN THE COURSE OF NEUTRON IRRADIATION OF TELLURIUM COMPOUNDS. Michel Bertet, Yves Chanut, and Roland Muxart (Institut du Radium, Arcueil, France). Radiochim. Acta, 2: 116-25(Mar. 1964). (In French)

Chemical transformations that accompany the ^{131}Te β^--emission were studied under different experimental conditions; especially the oxidation states of ^{131}I were examined, after neutron irradiation in crystals and different aqueous solutions of TeO_2 and telluric acid. With telluric acid the ratio of the ^{131}I oxidation states: reduced fraction (I^{*-}, I^*O^-, I^*_2), iodate and periodate, depend on the solvent and on the irradiation method (crystalline or dissolved target). In the first case the reduced fraction grows from 12 to 89% when the solvent changes from nearly neutral to 0.8 M HNO_3. In the second case the reduced fraction amounts to 89% in neutral or acid solution, and to 64% in 0.5 M KOH. With TeO_2 in alcaline solution the reduced fraction varies little with the irradiation method (46% with crystalline and 56% with dissolved target). The nitric solution, on the other hand, is highly unstable; therefore the properties of the different iodine oxidation states vary with the analytic conditions. (auth)

33662 EXPERIMENT ON THE IDENTIFICATION OF THE CHEMICAL PRODUCTS IN $Na_2IrCl_6 \cdot 6H_2O$ RESULTING FROM THE NUCLEAR REACTION $^{191}Ir(n,\gamma)^{192}Ir$. R. Bell and W. Herr (Kernforschungsanlage, Jülich, Ger. and Universität, Cologne). Radiochim. Acta, 2: 125-32(Mar. 1964). (In German)

In the $Na_2IrCl_6 \cdot 6H_2O$ system numerous recoil compounds from the $^{191}Ir(n,\gamma)^{192}Ir$ process can be separated electrophoretically. They are mostly anionic, but two ^{192}Ir labeled cations are found, too. The chemical behavior of these products, which are carrier-free with some exceptions, was studied during recrystallization in 1n HCl solution or reduction of Ir(IV) to Ir(III). The simultaneous application of activation analysis proved very helpful to the explanation of the hydrolysis of the hexachlorocomplexes (labeled by ^{36}Cl and ^{192}Ir) of ter- and quadrivalent Ir. With this information the nature of the ^{192}Ir recoil compounds in the pherogram could be clarified rather completely. Most of them are octahedral complexes of Ir^{3+} with different amounts of Cl^-, H_2O, and OH^- ligands. The six molecules of constitutional water influence via ions and radicals the recombination and stabilization reactions; they explain the formation of Ir complex compounds partially unknown until now. (auth)

33663 HOT-ATOM CHEMISTRY AND THERMAL DECOMPOSITION OF SODIUM AZIDE CRYSTALS CONTAINING NITROGEN-13 RECOIL ATOMS. B. Reitzner and G. Harbottle (Brookhaven National Lab., Upton, N. Y.). Radiochim. Acta, 2: 132-8(Mar. 1964). (BNL-7322)

The reactions of recoil ^{13}N atoms produced by the (n,2n) reaction in sodium azide were studied: labeled azide and nitrogen (N_2) are the principal products, with yields of about 30 and 65%, respectively. The yield of azide shows little dependence on temperature. When samples of the irradiated salt are subjected to thermal decomposition, the specific activity of the nitrogen evolved first falls, then rises and shows a peak during the induction period for bulk decomposition. This behavior is interpreted in terms of displacement spike theory. (auth)

33664 ISOLATION OF CARRIER-FREE ^{202m}Pb AND ^{203}Pb. Sara M. Abecasis (Universidad Nacional, La Plate, Argentina). Radiochim. Acta, 2: 156-7(Mar. 1964).

A method is described for the preparation of carrier-free ^{202m}Pb and ^{203}Pb by means of the irradiation of Tl_2SO_4. The method produces a solution of ^{202m}Pb and ^{203}Pb suitable for use in β spectroscopy and entirely free from ^{32}P. (P.C.H.)

33665 ISOLATION OF CARRIER-FREE ^{90m}Y AND ^{93m}Mo. Sara M. Abecasis (Universidad Nacional, La Plata, Argentina). Radiochim. Acta, 2: 157-9(Mar. 1964).

A method is described for the preparation and isolation of carrier-free ^{90m}Y and ^{93m}Mo, by means of one single irradiation. To prepare ^{90m}Y, spectroscopically pure metallic Nb was irradiated with 28 Mev deuterons, and ^{90m}Y was formed by means of the nuclear reaction $^{93}Nb(d,\alpha p)^{90m}Y$. The separation and subsequent purification of ^{90m}Y is based to a great extent on the coprecipitation of Y with LaF_3 or SrF_2, and its subsequent extraction with di(2-ethyl-hexyl) phosphoric acid. ^{93m}Mo was formed by means of the nuclear reaction $^{93}Nb(d,2n)^{93m}Mo$. The separation and subsequent purification of carrier-free ^{93m}Mo is based on its coprecipitation with CuS and later extraction of ^{93}Mo with diethyl ether from a solution of 6 N HCl. (P.C.H.)

33666 SZILARD-CHALMERS EFFECT IN SOLID XENON TETRAFLUORIDE. K. Starke and E. Guenther (Universität, Marburg, Lahn, Ger.). Radiochim. Acta, 2: 159-60(Mar. 1964).

A simple technique was used to detect at least qualitatively a possible Szilard-Chalmers effect in solid XeF_4. Target samples weighing 9-50 mg were irradiated for 55 min with a neutron flux of 3×10^{11} n/cm^2. For 37.2 mg of XeF_4 present before sublimation, a specific activity of 250 counts/min·mg was estimated. After two sublimations, an amount of 29.0 mg survived with a specific activity of about 140 counts/min·mg. It was concluded that the fraction of the activity present as elementary Xe is of the same order of magnitude as the retention. This would mean that in the solid a great number of recoil atoms pick up fluorine from neighboring XeF_4 molecules to form at least a difluoride. (P.C.H.)

33667 PURIFICATION OF ORGANIC MODERATORS-COOLANTS FOR REACTORS. Giuseppe Basso. Riv. Ing. Nucl., 2: 304-11(Jan.-Apr. 1964). (In Italian)

The characteristics of an irradiated organic coolant and the factors leading to the coating of the fuel elements with impurities are examined. The mechanism for the formation of the deposits on the fuel elements is proposed. (J.S.R.)

33668 INVESTIGATION OF THE OXIDATIVE DESTRUCTION OF POLYAMIDES. I. STUDY OF THE THERMAL AND RADIATIONAL OXIDATION OF POLYCAPROLACTAM BY THE METHOD OF INFRA-RED SPECTROSCOPY. L. A. Kotorlenko, A. P. Gardenina, and V. G. Oleinik. Ukr. Khim. Zh., 30: 370-6(1964). (In Russian)

Studies were made of the infrared spectra of polycaprolactam films during thermal oxidation at 120 to 200°C and radiation oxidation at 30°C. The results showed almost identically diminishing optical band densities of C–H bond oscillations in methyl groups, amide I and amide II caused by the disintegration of methyl and peptide groups. The growth of the optical density bond at 1713 cm$^-$ for C = 0 oscillations during oxidation indicated the formation of carbonyl compounds. An absorption increase in the 800

to 1200 cm^{-1} region during radioinduced oxidation indicated the development of hydroperoxide ether and various linked structures. Stabilizing effects of N, N'-di-β, β'-naphthyl-n-phenylenediformylamide were studied as a function of concentration. The highest stabilizing effect was achieved with 0.5% antioxidant during thermal oxidation and with 0.3% during radiation oxidation. (R.V.J.)

33669 INVESTIGATION OF THE OXIDATIVE DESTRUCTION OF POLYAMIDES. II. INVESTIGATION OF THE FREE RADICALS IN RADIOLYSIS AND RADIATION OF POLYCAPROLACTAM. A. S. Fomenko, T. M. Abramova, E. P. Dar'eva, A. A. Galina, and E. G. Furman. Ukr. Khim. Zh., 30: 376-84(1964). (In Russian)

Free radicals produced by g irradiation of polycaprolactam, their participation in the radiolysis, and the radiolysis-inhibiting effects of di-β-naphthyl-n-phenylenediamine were studied. Va reactions in the EPR spectra of polycaprolactam and caprolactam oligomers were analyzed as functions of radiation dose, temperature, and oxygen content. In the gaseous products of polycaprolactam radiolysis in a vacuum, the ratio of hydrogen: CO is 3:1 with 3% CO_2. Introduction of 0.5 to 3% of di-β-naphthyl-n-phenylenediamine does not alter the EPR spectrum or the concentration of free radicals produced. Additions of the antioxidant reduced the amounts of hydroperoxides and carbonyl compounds produced. (R.V.J.)

33670 THE IR SPECTRA OF ACRYLONITRILE–α-METHYLFURAN COPOLYMERS. P. P. Larin, U. N. Musaev, Yu. T. Tashpulatov, R. S. Tillaev, and Kh. U. Usmanov. Vysokomolekul. Soedi., 6: 997-1000 (June 1964). (In Russian)

The results of an IR study of copolymers of acrylonitrile with α-methylfuran (sylvan) are presented. The copolymers were prepared by irradiating various ratios of the monomers both neat and in the dissolved states with ^{60}Co γ rays. The IR spectra confirmed the formation of copolymers. It is suggested that radiation copolymerization of acrylonitrile and sylvan in solution leads to addition of the solvent to the copolymer. This is apparently associated with cyclization of the polyacryl segments with the formation of conjugated C = N bonds to which may be ascribed the 1665 cm^{-1} band. (auth)

33671 STUDIES ON X-AGENT. XXXIV. EFFECT OF X-AGENT ON PRECIPITATION OR CRYSTALLIZATION OF NEUTRAL RED. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 15: 11-22 (Feb. 1964).

The degree of precipitation or crystallization of neutral red induced by X-agent was estimated by the method devised by Bergter and his coworkers. It was found that the degree would vary markedly with place and time in which the investigation was performed. Shielding effect of tin plate and lead pile was demonstrated. Day-night difference was found in the effect of such metallic shields. This difference did not develop under the covering of black paper, although the effect of the metallic shield was never diminished by this covering. This shows that the difference is caused by a very soft component or components, which have a direct connection with the sum. The degree of pigment precipitation was affected even by a shield of thick paper, another fact which indicates the involvement of some soft component in the precipitation. It is believed that soft components of the X-agent are concerned in this phenomenon, since ordinary light or heat ray has nothing to do with it. Its hard components are considered to be able to freely pass through 5-cm lead shield, because the degree of the pigment precipitation was changed inside the lead shield as strongly as outside the shield. From the continued observations with frosted glass surface or methyl-red solution, it was previously concluded that the X-agent undergoes pronounced seasonal variation, thereby the activity being very obscure in late winter or early spring, while very strong in early summer. Such a variation failed to be observed in the pigment precipitation. This is attributed to dissimilarity among various test materials in their sensibility to X-agent. Probably neutral red is sensitive to some component of X-agent to which the frosted glass surface and methyl-red solution are insensitive. (auth)

33672 STUDIES ON X-AGENT. XXXV. INFLUENCE OF BLACK-PAPER COVERING ON THE PRECIPITATION OR THE CRYSTALLIZATION OF NEUTRAL RED. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 15: 23-31(Feb. 1964).

The precipitation or the crystallization of neutral red was affected markedly by X agent when the test tubes containing the pigment solution were covered with a sheet of black paper. This influence was found very marked when the investigation was carried out close by a south window; it was not so evident by a north window. The agent concerned must have been entering in the main from a south window. Ordinary light or heat ray was not concerned. Thus radiations emitted either by an electric lamp or by an electric heater could have no effect on the precipitation. The influence could be observed not only in day-time but also in night-time, showing that the agent was coming also in night-time. It is believed that some soft component of the X-agent was responsible for this phenomenon. The influence evidently varied from day to night. In most cases the feature of the influence in day-time was found to be the reverse of that in night-time. This shows that the X-agent in the day exhibited an action quite opposite to that in night-time. (auth)

33673 STUDIES ON X-AGENT. XXXVI. INFLUENCE OF WATER ON THE SEDIMENTATION OF NEUTRAL RED, AND RELATION BETWEEN THE HARDNESS OF X-AGENT AND ITS ACTION. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 15: 35-47(Apr. 1964).

The influence of water on the sedimentation of neutral red was demonstrated by putting a number of test tubes containing the same neutral-red solution in each small glass vessel either containing water or empty. The influence was also observed around a bottle of water. It was concluded that the secondary X-agent emitted from the water was involved in the sedimentation. The manner of the influence of the water was generally reverse between day and night. The water caused, as a rule, the decrease of the sedimentation in night-time, with an increase in day-time. Such an inversion phenomenon was seen occasionally even in the same day-time when the place of the observation was altered. Thus the sedimentation in day-time was increased by the water in a place close by a south window, while it was decreased in a place far away from the window. The water effect was observed also in a small room made from 5-cm thick lead blocks, showing that the hard component freely penetrable through the lead blocks could have influence on the sedimentation after being changed into secondary agent by the water. The sedimentation took place more pronouncedly inside the lead blocks than outside. However, this occurred as a rule in night-time; in day-time the degree of the inside-sedimentation tended to be the same as outside-sedimentation. It is in-

ferred that the hard component promotes the sedimentation, while the soft one inhibits it, but that the latter can be interfered by some solar radiation coming in day-time so that the action is inverted to develop the same sedimentation-promoting action as the hard component. (auth)

33674 THE RADIOCHEMICAL POLYMERIZATION OF SOME OPTICALLY ACTIVE MONOMERS. Rolf C. Schultz (Universität, Mainz and Hahn-Meitner-Institut für Kernforschung, Berlin). Z. Naturforsch., 19b: 387-92(May 1964). (In German)

Optically active monomers were obtained by double decomposition of l-menthol with acrylic acid, methacrylic acid, or vinyl isocyanate. The menthyl esters of acrylic and methacrylic acids can be polymerized alone or in solution between +20 and −78° with azoisobutyric acid nitrile, Grignard compounds, or Co γ radiation. N-vinyl carbaminic acid l-menthyl ester can be polymerized by γ radiation only in solution, and not in the crystalline state. All polymers are optically active. The magnitude of the molar rotation value and the wave lengths of the Cotton effect depends on the growth mechanism. From the comparison of these measurement values it was concluded that radiochemical polymerization of acrylic and methacrylic esters at −78° in the vitreous state proceeds by a radical mechanism. Transparent optically active molded bodies can be obtained by polymerization of the monomers alone up to a complete transformation. (tr-auth)

33675 ON THE RADIATION-INDUCED RADICAL FORMATION IN THE WATER–AMINOACID SYSTEM. G. Lassmann (Forschungsgemeinschaft der Medizinisch-Biologischen Institute, Berlin). Z. Physik. Chem. (Leipzig), 225: 409-17(1964).

Frozen aqueous amino acid solutions were subjected to x irradiation at the temperature of liquid air and examined for radical formation by means of electron spin resonance techniques. The type of radical formed was established by taking into account the electron spin resonance spectrum of the water. The effects of the amino acid molecule and the OH radicals in water are discussed. The respective amino acid radicals were identifiable in every instance. (OTS)

33676 PHYSIKALISCHE KERNCHEMIE. (Physical Nuclear Chemistry). Ulrich Schindewolf. Brunswick, Friedr. Vieweg & Sohn, 1959. 200p. DM 10.80.

The principles of physical nuclear chemistry as they evolved in lectures at American and German colleges are presented. The book is intended as an introduction to nuclear physics for the chemist and requires no profound knowledge of theoretical physics and mathematics. The topics discussed are the nucleus and its decay, nuclear systematics and energetics, nuclear models, results of the theories of α, β, and γ decay, nuclear reactions, the neutron and its reactions, fission of heavy nuclei, occurrence and frequency of the elements, laws of radioactive decay, chemistry of trace elements, isotope separation, interactions of radiation with matter, application of radiochemical and nuclear chemical methods in nuclear analysis, and geochemistry. (J.S.R.)

33677 A PROCEDURE FOR THE DETERMINATION OF ALPHA EMITTING PLUTONIUM IN URINE USING A SOLID-STATE COUNTER. F. J. Sandalls and A. Morgan (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/9, 18p. (CONF-448-8)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

A method is described for the routine determination of alpha emitting plutonium in urine. In evolving this procedure various techniques for concentrating, purifying and electrodepositing plutonium were compared and these investigations are summarized. In the procedure finally adopted, urine is wet ashed and the residue dissolved in hydrochloric acid. Plutonium(IV) is coprecipitated with iron cupferride from this solution and extracted into chloroform. After evaporation of the chloroform, the residue is oxidized, dissolved in hydrochloric acid and the iron extracted into di-isopropyl ether. The aqueous phase containing the plutonium is evaporated and dissolved in an acid ammonium sulphate solution from which the plutonium is electrodeposited onto stainless steel. Quantitative recoveries are obtained over the electrodeposition stage and on over-all recovery of 84 ± 7%. The electrodeposited plutonium is counted with a surface-barrier junction diode (solid-state) detector in a counter developed for this purpose. The low inherent background of this type of counter is effectively reduced still further by counting only those alpha particles with energy in the 4.2 − 5.4 Mev range. The good resolution which can be obtained with thin electrodeposited sources of plutonium enables this narrow channel to be used with only small losses in counting efficiency. By counting over this restricted energy range, the blank activity arising from reagents and incomplete decontamination from other alpha emitters in urine is also reduced by a factor of two, to just over 0.01 pc/24-hour sample. (auth)

Separation Processes and Procedures

Refer also to abstract 33856.

33678 (ANL-6875) CHEMICAL ENGINEERING DIVISION RESEARCH HIGHLIGHTS, MAY 1963–APRIL 1964. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 192p.

Research and development progress is reported on melt refining, pyrometallurgical processes employing liquid-metal solvents, chemistry of liquid metals, fuel processing facility for EBR-II, preparation of fuels for fast reactors, fuel cycle applications of volatility and fluidization techniques, high-temperature fuels and materials, calorimetry, metal-water reactions in a reactor, metal oxidation and ignition, energy conversion, determination of nuclear constants, and analytical chemistry. (M.C.G.)

33679 (JEN-136-DQ/I-40) MÉTODOS DE EXTRACCIÓN CON DISOLVENTES APLICADOS AL ANÁLISIS QUÍMICO DEL URANIO. I. ESTUDIO DE LA EXTRACCIÓN CON FOSFATO DE TRIBUTILO-METILISOBUTILCETONA. (Solvent Extraction Systems Applied to Uranium Analysis. I. Extraction Studies with Tributyl Phosphate–Methyl Isobutyl Ketone). J. Vera Palomino, F. Palomares Delgado, and J. C. Petrement Eguiluz (Spain. Junta de Energía Nuclear, Madrid). 1964. 25p.

A factorial study of the selective extraction of uranium with a mixture of TBP–methyl isobutyl ketone was carried out using 0.8 N nitric acid and different salting agents. The most suitable salting agent was used to develop new factorial experiments in order to get an equation involving the percent of extracted uranium, E, the concentration of the extractant in the organic phase, c, and the concentration of the salting agent in the aqueous phase, n. The following equation was found: $\log E = 2 - 0.6^{[c/2]-1}\,[(2.33/2.46^{n}) -$

0.04]. From this equation the iso-extraction curves are obtained in the c, n plane, where the best working conditions are chosen. The effect of the acid concentration on the extraction was also studied. (auth)

33680 (JEN-137-DQ/I-41) MÉTODOS DE EXTRACCIÓN CON DISOLVENTES APLICADOS AL ANÁLISIS QUÍMICO DEL URANIO. II. ESTUDIO DE LA EXTRACCIÓN CON FOSFATO DE TRIBUTILO-ACETATO DE ETILO. (Solvent-Extraction Methods Applied to the Chemical Analysis of Uranium. II. Study of the Extraction with Tributylphosphate-Ethyl Acetate Mixtures). J. Vera Palomino, F. Palomares Delgado, and J. C. Petrement Eguiluz (Spain. Junta de Energía Nuclear, Madrid). 1964. 9p.

The extraction of uranium on the trace level was studied by means of the solvent system tributyl phosphate–ethyl acetate under conditions of constant acidity by using aluminum, calcium, and ammonium nitrates as salting-out agents. For calcium nitrate, which appeared to give optimum results, the following equation was obtained: $\log E = 2 - 0.54^{(c/2-1)} [(3.05/2.59^{n}) - 0.032]$ relating the percent of extracted uranium, E, with the concentrations of tributyl phosphate in ethyl acetate, c, and calcium nitrate in the aqueous phase, n. The curves of equal extraction are obtained in the c, n plane, where from the optimum extraction conditions may be easily inferred for any given case. (auth)

33681 (JEN-138-DQ/I-42) MÉTODOS DE EXTRACCIÓN CON DISOLVENTES APLICADOS AL ANÁLISIS QUÍMICO DEL URANIO. III. ESTUDIO DE LA EXTRACCIÓN CON DISOLVENTE INERTES. (Solvent-Extraction Methods Applied to the Chemical Analysis of Uranium. III. Study of the Extraction with Inert Solvents). J. Vera Palomino, F. Palomares Delgado, and J. C. Petrement Eguiluz (Spain. Junta de Energía Nuclear, Madrid). 1964. 20p.

The extraction of uranium on the trace level is studied by using tributylphosphate as active agent under conditions aiming the attainment of quantitative extraction by means of a single step process using a number of salting-out agents and keeping inside the general lines as reported in two preceding papers. Two inert solvents were investigated, benzene and cyclohexane, which allowed one to derive the corresponding empirical equations describing the extraction process and the results obtained were compared with those previously reported for solvents which, like ethyl acetate and methylisobutyl-ketone, favor to a more or less extent the extraction of uranium. (auth)

33682 (ORNL-P-200) ANALYSIS OF THE COMBUSTION OF GRAPHITE–URANIUM FUELS IN A FIXED BED OR MOVING BED. Charles D. Scott (Oak Ridge National Lab., Tenn.). [July 22, 1964]. Contract [W-7405-eng-26]. 39p. (CONF-571-3)

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

A proposed first step in processing graphite–uranium nuclear fuels for the recovery of uranium is burning of the fuel. This process is carried out in a fixed bed or moving bed in which the fuel is burned by oxygen and/or air to remove the carbon and oxidize the uranium. To predict effects of operating variables and point out potential problems, an analysis was made of the reaction system for burning Ultra High Temperature Reactor Experiment (UHTREX) type of fuels. The analysis includes consideration of both reaction kinetics and mechanisms of heat transfer, and a mathematical model of the process was derived. Numerical solutions of the mathematical model were made with a CDC 1604-A digital computer. Results of the analysis compare favorably with experimental results, and several potential operational problems were revealed, such as high carbon monoxide content and excessive heating. Effects of change in operating conditions were determined, and safe operating conditions were predicted for deep beds of fuel in tubular and annular reactors in which the maximum temperature is less than 1300°C, the maximum wall heat flux is less than 7.5 cal/cm^2 sec, and the maximum carbon monoxide concentration is less than 12.5%. (auth)

33683 (TID-8540(p.411-76)) PYROPROCESSING OF REACTOR FUELS. R. Dean Pierce and Leslie Burris, Jr. (Argonne National Lab., Ill.).

Developments in pyrometallurgical processes for reactor fuel reprocessing are reviewed. The facilities and methods for fuel reprocessing for EBR-II are described. The magnesium process for Th–U fuels, the Hanford salt-cycle process for ceramic fuels of mixed oxides of Pu, Th, and U, a low-decontamination process for ceramic fuels, the mercury process for U (Hermex Process), an aluminum process for U, a process for liquid-metal fuels, and an electrolytic process are discussed. A bibliography of 176 references is presented. (R.E.U.)

33684 PECLET NUMBERS AND RETARDATION FACTORS FOR ION EXCHANGE COLUMNS. Isao Hashimoto, K. B. Deshpande, and Henry C. Thomas (Univ. of North Carolina, Chapel Hill). Ind. Eng. Chem., Fundamentals, 3: 213-18(Aug. 1964).

A solution for the problem of miscible displacement, or for the chromatographic problem involving a linear isotherm and dispersion, is given and adapted to a least squares calculation. The procedure enables utilization of all the data from column breakthrough experiments. The method is illustrated by a study of the velocity dependence of the dispersion coefficient. When applied to data not fulfilling the theoretical postulates, the method produces empirical descriptions of column behavior, a representation of column performance in terms of equivalent column volume, and a single additional parameter. The theory also gives excellent agreement for a case of slow isotopic exchange. (auth)

33685 SOLVENT EXTRACTION BEHAVIOR OF MACROAMOUNTS OF ELEMENTS IN 100% TBP-NITRIC OR HYDROCHLORIC ACID SYSTEMS. Tomitaro Ishimori, Eiko Akatsu, Akira Kataoka, and Tomiko Osakabe (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 18-21(Apr. 1964).

The acid dependence curves of 15 inorganic ions in macroamounts were surveyed for the system of 100% TBP-HCl and HNO_3 and were compared with results obtained in tracer work previously reported. In most cases, the distribution ratio Kd measured in a system containing 0.1 M/l salt are little different from those determined by radioactive tracers. The acid dependence behavior of ferric and zinc chloride were especially studied with varying metal ion concentrations. Additional experiments were carried out for ferric and zinc chloride in the system of 1%(w/v) TBPO and 5%(w/v) TOPO toluene-HCl. In these cases the Kd values lowered with increasing chloride concentration. (auth)

33686 THE EXTRACTION OF CURIUM AND AMERICIUM BY TRI-N-OCTYL PHOSPHINE OXIDE. Kenju Watanabe and Reiko Ono (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 75-6 (May 1964).

The extraction of curium by tri-n-octyl phosphine oxide (TOPO) from nitric acid solutions was studied, together with the extraction of curium, americium, and europium from ammonium nitrate solutions. The extraction of americium by 5% TOPO from hydrochloric acid solution was also investigated. (D.C.W.)

33687 PROCESSING OF GRAPHITE REACTOR FUELS CONTAINING COATED PARTICLES AND CERAMICS. R. E. Blanco, G. I. Cathers, L. M. Ferris, T. A. Gens, R. W. Horton, and E. L. Nicholson (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 20: 13-22(Sept. 1964).

Potential processing methods for graphite-matrix nuclear reactor fuels which contain coated particles and/or ceramics are discussed. Both nonaqueous and aqueous processing methods are being developed. Fuels containing either uncoated or carbon-coated particles generally are first burned in oxygen at 800–1200°C to eliminate the graphite as CO_2 and convert the uranium, thorium, and other metallic constituents of the fuel to their respective oxides. The combustion ash (oxides) can then either be treated by a nonaqueous volatility method or be dissolved or leached in a suitable aqueous reagent in preparation for decontamination and recovery of the fuel by solvent extraction. In the fluoride volatility and chloride volatility methods, the constituents of the ash are converted to the respective halides; decontamination and recovery is then achieved by selective volatilization in the fluoride volatility method and, possibly, with chloride volatility. The chlorides can also be dissolved in water in preparation for solvent extraction. Fuel particles coated with such materials as Al_2O_3, BeO, and SiC can be separated from the graphite matrix by a variety of methods other than burning; for example, disintegration of the fuel in boiling 90% HNO_3 or anodic disintegration in dilute nitric acid. Special methods are then required for recovery of the fuel. (auth)

33688 EXTRACTION AND SEPARATION OF TANTALUM AND NIOBIUM BY LIQUID-LIQUID EXTRACTION IN THE HYDROFLUORIC ACID–TRIBUTYL PHOSPHATE SYSTEM. Sanji Nishimura (Kyoto Univ.), Jyoichiro Moriyama, and Isao Kushima. Trans. Japan Inst. Metals, 4: 259-62(Oct. 1963).

The liquid-liquid solvent extraction and separation of Ta and Nb were studied, using tributyl phosphate (TBP) as an organic solvent and hydrofluoric acid solution as an aqueous solution. The extractability of a fluoride complex of Ta and Nb from HF solution into TBP was found to be a function of HF acidity, TBP concentration, oxide concentration, volume ratio of organic solvent to aqueous solution, and number of extraction operation. The Ta percentage extractions and the Ta distribution ratio decreased with an increase in HF acidity at a constant TBP concentration, but decreased with a decrease in TBP concentration at a constant HF acidity. The percentage extractions of Nb and Nb distribution ratio rose with a rise in HF acidity and TBP concentration. The separation factor augmented with diminishing HF acidity, especially under 3N HF. Both percentage extractions of Ta and Nb decreased inversely with the rising oxide concentration in aqueous solution. The increase in the volume ratio and frequency of extraction increased both percentage extractions of Ta and Nb. The organic extract extracted with TBP included little impurity. The HF–TBP system had larger extractability of Ta and Nb, particularly in low HF acidity, better separation factor, and higher purity of the organic extract than the HF–hexone system. (auth)

33689 SEPARATION OF RARE-EARTH ELEMENTS INTO SUBGROUPS BY MEANS OF CUPFERRON. M. A. Tishchenko, R. S. Lauer, and N. S. Poluektov. Ukr. Khim. Zh., 30: 390-5(1964). (In Russian)

Solubilities of rare earth cupferronates in cyclohexanone, cyclohexanol, ethyl acetate, and isoamyl alcohol were measured in order to determine conditions for rare earth separation into cerium and yttrium subgroups. Cerium cupferronates settle as precipitates while those of the yttrium group are quite soluble. Cyclohexanone proved to be the most effective solvent. However, the separation method is not yet refined and can be used only for a rapid approximate separation. (R.V.J.)

33690 PRECIPITATION OF ZIRCONIUM AND FLUORIDE IONS FROM SOLUTIONS. (to U. S. Atomic Energy Commission, Germantown, Md.). British Patent 963,613. July 15, 1964. Priority date Sept. 25, 1961, United States.

A process is given for the simultaneous precipitation of Zr and F ions from a solution containing U(VI), Zr, and HF. The process results in the removal of over 97% of both Zr and F ions, and the supernatant may be evaporated for further processing for U. In the process, the solution is treated with a quantity of sodium formate solution sufficient to provide at least two moles sodium formate for each mole Zr. Precipitation of Zr and F proceeds rapidly and completely at room temperature, while U remains in solution. Two examples of the application of the process to dissolver solutions are given. (D.L.C.)

33691 A PROCESS OF DISSOLVING FUEL ELEMENTS OF NUCLEAR REACTORS. (to U. S. Atomic Energy Commission, Germantown, Md.). British Patent 964,620. July 22, 1964. Priority date Nov. 2, 1961, United States.

A process is given for dissolving in one step UO_2-core fuel elements which are clad with stainless steel or Zr alloy. The process is based on the discovery that the addition of a copper substance to the molten $PbCl_2–Cl_2$ that is used in dissolving the clad, results in improved dissolution of the UO_2 core. The process comprises immersing the clad fuel element in molten $PbCl_2$ at 500 to 550°C, adding the copper substance, and bubbling Cl_2 gas through the mass. (D.L.C.)

33692 METHOD OF REPRODUCING UO_2 REACTOR FUEL. J. R. Foltz and W. J. Gardner (to U. S. Atomic Energy Commission). U. S. Patent 3,140,151. July 7, 1964.

A method of reprocessing sintered, irradiated, UO_2 reactor fuel is described. The UO_2 is first oxidized to U_3O_8 at a temperature of about 300 to 500°C, and the resulting comminuted U_3O_8 is reduced to UO_2 with hydrogen at a temperature of about 500 to 800°C. The resulting comminuted UO_2 is oxidized to U_3O_8 in air at a temperature of about 100 to 250°C, and the U_3O_8 is reduced to UO_2 with hydrogen at a temperature of about 250 to 500°C. (AEC)

ENGINEERING

General

Refer also to abstract 34649.

33693 (ACNP-64026) STEAM SEPARATION TECHNOLOGY UNDER THE EURATOM PROGRAM. Quarterly Progress Report, April 1–June 30, 1964. Ralph Klumb, William Littleton, William Meyer, James Weber, John Wilson, and Howard Yant (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). July 10, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1186. 67p. (EURAEC-1131)

Carryunder tests in steam-water natural separation system were completed at 600 to 2000 psig. Results show that at the higher pressure ranges (~1400 to 2000 psig) gross carryunder occurs at very low downcomer velocities. Hooded crossover separator tests were completed in air-water. Several separator configurations were tested and the best design was selected for testing in steam-water. Results show this type of separator may work well in a natural circulation boiling water reactor. A radial arc type separator was tested in air-water and test results are reported. Tests of upcomer type separators in the air-water column were completed. The analytical method of predicting separator flow characteristics was adjusted to agree with actual performance. A chevron type steam dryer was installed in the steam-water facility and testing is in progress. Steam volume fractions in the riser section of the test setup utilized in both the downflow centrifugal separator test and the carryunder in natural separation test setups were measured. (auth)

33694 (HW-76850) THERMAL STRESS ANALYSIS OF A BIMETALLIC TUBE JOINT FOR "N" REACTOR APPLICATION. W. J. Love (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 13, 1963. Contract AT(45-1)-1350. 13p.

A mathematical stress analysis procedure was developed and applied to a prototype zirconium–carbon steel prototype process tube joint of the scarf type for the "N" reactor. The thermal stresses computed for the condition of heating from 70 to 470°F produced maximum scarf joint tensile and shear separation stresses of less than a ksi and therefore appear to be quite small. A rather high tensile stress of 40 ksi was computed for the tip cross section of the zirconium scarf; however the base metal fatigue properties do not indicate that failure would occur within the expected service life cycles unless adversely affected by local corrosion or severe thermal quench. (auth)

33695 (NASA-TN-D-2348) FUSED FLUORIDE COATINGS AS SOLID LUBRICANTS IN LIQUID SODIUM, HYDROGEN, VACUUM, AND AIR. Harold E. Sliney, Thomas N. Strom, and Gordon P. Allen (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Aug. 1964. 17p.

Fused coatings of CaF_2–BaF_2 mixtures were effective solid film lubricants for nickel–chromium alloys submerged in liquid sodium at 1000°F and sliding at a velocity of 2000 ft/min. Under these conditions, the coatings were not damaged after 2 hours of sodium exposure. Coatings of LiF and CaF_2–LiF mixtures lubricated effectively in sodium, but LiF was slowly dissolved and could not be considered for prolonged exposure. These coatings also showed lubricating potential in hydrogen, vacuum, and air. (auth)

33696 (NASA-TN-D-2401) EXPERIMENTAL INVESTIGATION OF HEAVY-MOLECULE PROPELLANTS IN AN ELECTRON-BOMBARDMENT THRUSTOR. David C. Byers, William R. Kerslake, and Jack Grobman (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Aug. 1964. 38p.

The performance of several molecular propellants in an electron-bombardment thrustor was investigated. Data indicated that ion-chamber-discharge phenomena were of more importance than type of molecule in the determination of the average mass of the ions in the exhaust beam. The ratio of average beam ion to parent molecule mass was always less than 0.5 and never exceeded 0.3 at propellant utilization efficiencies in excess of 20 percent. No significant increases in average ion mass were obtained by variation of several thrustor electrical and geometric parameters. Overall thrustor efficiencies were always less than 35 percent and were generally less than 10 percent at low values of propellant-utilization efficiency, where the average ion mass tended to increase for some propellants. (auth)

33697 (SWRI-1228-26) FUNDAMENTAL INVESTIGATION OF LIQUID-METAL LUBRICATED JOURNAL BEARINGS. Quarterly Technical Report No. 1. R. A. Burton and H. J. Carper (Southwest Research Inst., San Antonio). July 1, 1964. Contract AT(11-1)-1228. 45p.

The fundamentals of liquid-metal lubricated hydrodynamic bearings are investigated in order to develop the design criteria and performance estimates of journal bearings. Primary effort is devoted to the study of turbulent film phenomena, inertia effects, and surface tension effects. Solutions are provided for the interactions of weak pressure flows with a strong Couette flow, as would be experienced in turbulent film bearings. (N.W.R.)

33698 DEVELOPMENT OF AUTOMATIC CONTROL SYSTEMS FOR ELECTRON BOMBARDMENT AND CONTACT ION ENGINES. R. M. Worlock, A. T. Forrester, G. L. Hoyt, S. Lyons, G. W. Purmal, A. M. Schneider, and G. Sohl (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-504, 11p. $1.00. (CONF-600-1)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

Integrated systems consisting of an ion engine, a cesium feed system suitable for operation in a zero-g environment, and an automatic control system were built using both electron bombardment and surface ionization engines. The control system starts the engine, brings it to a predetermined level of operation, maintains thrust at a predicted level, and shuts the engine down upon command. The systems and their operation are described. (D.C.W.)

33699 DESIGN AND PERFORMANCE OF ION ENGINE SYSTEMS FOR CONTROL OF EARTH SATELLITES. G. A. Work, J. H. Molitor, M. H. Kaplan, and C. R. Collett (Hughes Research Labs., Malibu, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-501, 61p. $1.00. (CONF-600-3)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

An ion engine system developed for altitude control and

station maintenance of synchronous satellites is described, together with system testing and optimization. Control requirements for nonsynchronous satellite systems and manned space stations are also presented, together with the design of suitable station-keeping systems. (D.C.W.)

33700 SYNCOM 2 ELECTRICAL POWER SYSTEM. P. S. DuPont (Hughes Aircraft Co., Los Angeles). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-456, 7p. $1.00. (CONF-600-9)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The electric power system for SYNCOM 2, a synchronous altitude active communication satellite launched on July 26, 1963, is discussed, including power system design criteria and actual and predicted performance. The calculation of the equivalent radiation environment is summarized, and differences between the power systems for SYNCOM 1, 2, and C are outlined. (D.C.W.)

33701 ELECTROSTATIC SEPARATORS FOR A ZERO-GRAVITY ENVIRONMENT. H. Weiner (Republic Aviation Corp., Farmingdale, N. Y.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-448, 19p. $1.00. (CONF-600-12)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

An electrostatic technique for phase separation in space power systems using a Rankine cycle is discussed, which is based on the dielectrophoretic effect. The equations are derived for a first approximation of the effect and are applied to the preliminary design of a separator for a two-fluid (Li and Cs) Rankine cycle. The weight of the separator would be about 0.3 lb/kwe. Preliminary tests verifying the existence and potential usefulness of the dielectrophoretic separation phenomenon are summarized, and problems in the development of a practical system are considered. A technique combining electrostatic and centrifugal separation methods is also described. (D.C.W.)

33702 ELECTRIC PROPULSION IN 1964—A STATUS REVIEW. Ernst Stuhlinger (National Aeronautics and Space Administration, Huntsville, Ala.). New York, American Inst. of Aeronautics and Astronautics, 1964. Paper No. 64-524, 7p. $1.00. (CONF-600-17)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The status of electrodynamic, electrostatic, and electrothermal thrustors is summarized, together with developments in space testing and mission planning for electric propulsion systems. The status of power supplies for such systems is also considered. (D.C.W.)

33703 SOLAR SIMULATION TESTING OF THE NUCLEAR TEST DETECTION SPACECRAFT. K. L. Goldman, E. E. Glenn, S. N. Lehr, and J. E. Norris (TRW Space Technology Labs., Redondo Beach, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-209, 15p. $1.00. (CONF-600-21)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

A three-step test plan was carried out using a vacuum chamber with carbon-arc lamps for solar simulation. An engineering model was tested first to verify the design of the thermal control subsystem and the performance of the solar simulation equipment. A prototype spacecraft then underwent an operational qualification test, and each flight spacecraft received an operational acceptance test. The test procedures, equipment, and results are described. (D.C.W.)

33704 EXPERIMENTAL SYSTEMS STUDIES OF LARGE MODULES AND ARRAYS OF ELECTROSTATIC THRUSTORS. Paul D. Reader and William R. Mickelsen (Lewis Research Center, Cleveland). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-503, 11p. $1.00. (CONF-600-22)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

Performance characteristics and power requirements of existing electron-bombardment thrustors are presented in a form useful to electric-propulsion-system analysis and design. This information is based on experimental operation of laboratory thrustor modules of 5 to 50 cm in diameter and module and array power levels up to 30 kw. Designs are shown for two multidirectional, nongimbaling thrustors of the size appropriate for satellite station keeping and attitude control. Static and dynamic control characteristics of electron-bombardment thrustors are summarized. From these data, it is evident that no serious problems should arise in control-system design. A thrustor circuit design is described that suppresses electric breakdowns to a magnitude sufficiently small to eliminate damaging interaction between the thrustor and the power-conversion system. It is shown that power-conversion and thrustor weights and losses could reduce the payload of a 500-kw, 28,500-lb Mars-orbiter vehicle by 5000 to 9000 lb. It is also shown that the thrustor array for this vehicle would fit well within the payload shroud of Saturn IB booster. (auth)

33705 DEVELOPMENT STATUS OF LOW POWER ARC-JET ENGINES AND THEIR APPLICABILITY TO NEAR FUTURE SPACE MISSIONS. W. A. Geideman, Jr., K. Muller, and J. W. Rosenbery (Giannini Scientific Corp., Santa Ana, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-502, 11p. $1.00. (CONF-600-23)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The design and development of a 2-kw arc-jet thrustor is summarized, together with endurance and performance tests of 1- and 2-kw thrustors. A 2-kw unit was operated continuously for 150 hours, and specific impulse levels approaching 1270 sec were achieved with a unit of the same design. Some applications of such devices are outlined. (D.C.W.)

33706 APPLICATION OF AN ELECTROTHERMAL ARC JET PROPULSION SYSTEM TO A MANNED ORBITING RESEARCH LABORATORY. Ivan Tobias and R. Kosson (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-499, 17p. $1.00. (CONF-600-24)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The use of an electrothermal arc jet propulsion system to control the altitude and maintain the orbit of a manned orbiting research laboratory was considered. It was assumed that the MORL would be placed in a circular orbit at an altitude of 200 nautical miles. The total impulse required was based upon a continuous thrust requirement of 0.10 pounds. The electrical energy required is supplied by a photovoltaic system. The increased drag force due to the additional solar cell paddles is accounted for by including this as a further requirement of the arc-jet reaction control system. The other subsystems considered were: momentum flywheels to store disturbances in the dark portion of the orbit; batteries to accelerate the flywheels; propellants; propellant storage. Hydrogen is the

recommended propellant along with cryogenic storage. Fourteen engines are used with a total mass for the arc-jet system of approximately 6785 pounds. By comparison, a storable chemical propulsion system with a specific impulse of 300 seconds has a mass of 11,800 pounds. (auth)

33707 A RADIATION COOLED NUCLEAR ROCKET NOZZLE FOR LONG FIRING DURATIONS. Sidney Elkind (Arde-Portland, Inc., Paramus, N. J.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-389, 15p. $1.00. (CONF-600-33)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

A feasibility study was made of an uncooled nozzle for a twenty minute firing. A 15,000-Mw reactor using 1000 psia hydrogen at 4500°F was considered. The analysis consisted of the determination of the transient temperature distribution within the proposed nozzle walls. Modes of heat transfer considered were: gas convection; internal heat generation due to gamma attenuation; conduction; and radiation to space. Design requirements were met by a shielded composite wall of tungsten, graphite, pyrolytic graphite and Rene 41. (auth)

33708 IMPROVEMENTS IN OR RELATING TO DEVICES FOR HERMETICALLY JOINING TWO TUBULAR ELEMENTS. (to Commissariat à l'Energie Atomique). British Patent 966,535. Aug. 12, 1964. Priority date Aug. 9, 1961, France.

A device is designed for rigidly and hermetically assembling one end of a tube within a concentric sheath. The device comprises means mounted on the two tubular elements which cooperate together to interlock the elements in the axial direction. A thin annular lip is provided on one of the elements and engaging in the other element, and a ring with a radially truncated surface is provided which axially passes into the lip to urge it against the adjacent opposed radial surface of the other tubular element. (D.L.C.)

Applications of Nuclear Explosions

Refer also to abstracts 34973 and 35178.

33709 (SC-TM-64-636) A PROPOSAL FOR A FULL SCALE SUBMARINE TEST FACILITY. G. J. Simmons and L. J. LaPaz (Sandia Corp., Albuquerque, N. Mex.). Apr. 1964. Contract [AT(29-1)-789]. 25p.

This proposal was stimulated by a BUSHIPS requirement for a basic design for a full scale submarine test facility capable of accepting an operational submarine and subjecting it to dive conditions is proposed. One of the major engineering problems which must be solved is the construction of a pressure chamber capable of accepting a Triton class submarine (447 ft length) and subjecting it to the required 900 psi. This proposal is devoted to an analysis of the possible construction of the pressure chamber in a granitic sea cliff by the use of contained nuclear explosions. The granite chamber formed by such a means will then be used to contain the high pressures necessary for such a test facility. Calculations show that it will require four 1 kt shots to create the chamber, at a total cost of five million dollars. (auth)

33710 BLOCK CAVING, NUCLEAR STYLE. David D. Rabb (Univ. of California, Livermore). Mining Eng., 5p. (Mar. 1964). (UCRL-7608)

Mining and drilling operations in the chimney of broken rock produced by the Hardhat event proved that the rock could be mined by a modified block caving withdrawal technique. Radiation levels in the crushed rock were found to be acceptable, and it was verified that the size of the chimney can be predicted within limits. (D.C.W.)

Facilities and Equipment

Refer also to abstracts 34245, 35049, and 35050.

33711 (AERE-M-1373) DESIGN OF A LOW INERTIA AIR HEATER FOR A GRAPHITE CHANNEL OXIDATION EXPERIMENT. R. J. Moulton and E. Lyall (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). June 1964. 8p.

An air heater design is described which is suitable for use in a graphite channel oxidation experiment. Results are given of experiments on a prototype heater. (auth)

33712 (HW-53440) DEVELOPMENT OF A VALVE FOR THE CONTROL OF STREAMS COMPOSED OF POWDERED OR GRANULAR SOLIDS. J. M. Gerhart (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1, 1957. Contract AT(45-1)-1350. 8p.

A valve containing no moving parts has been developed which will control the flow of powdered or granular solids while maintaining a pressure differential across the valve. This valve makes use of the fact that all powdered or granular solids have an angle of repose and further, this angle of repose can be destroyed, i.e., made equal to zero, by fluidizing the portion of the bed subtended by the angle of repose. A model of this valve has been built and tested. These tests have proven the operability of the valve and have demonstrated the ability of the valve to maintain a seal while delivering a flow ranging from zero flow to a maximum flow determined only by the size of the valve. A typical installation of the valve is shown. (auth)

33713 ION-EXCHANGE UNIT FOR THE PRODUCTION OF REACTOR FEED WATER. V. D. Ganzha, K. A. Konoplev, V. D. Trinin, and V. T. Sharov. At. Energ. (USSR), 16: 456-7(May 1964). (In Russian)

Apparatus used to desalinate artesian water without previous purification by other methods is described. Water of high quality, with total salt content 1 mg/l and chlorine ions less than 0.02 mg/l, is obtained for reactor and other laboratory uses. The production of the apparatus is 3 m^3/hr. The ion exchange apparatus includes four ion filters, using a KU-2 cationite and EDE-10P anionite and each being fed 250 l of swollen resin. Results of chemical analysis of the initial and the desalinated water, giving dry residue, electric resistance, pH, oxidation, and content of Ca^{2+}, Mg^{2+}, Na^{+}, Fe^{2+}, Cl^{-}, HCO_3^{-}, SO_4^{2-}, and SiO_2, are presented. (M.J.T.)

33714 DESIGN OF A 300,000-Oe TWO-REGION SOLENOID FOR INTERMITTENT OPERATION. Richard Stevenson (McGill Univ., Montreal). Can. J. Phys., 42: 1343-57(July 1964).

A design for an aluminum solenoid magnet system capable of producing a field of 300 kgauss over a bore of 5.8 cm is presented. The magnetic field is produced by a two-region solenoid operated 15°K and cooled by compressed helium. The magnet is designed for a total operating time at maximum power of at least 40 min/week. The structure is described, and calculations for the cooling system are summarized. (auth)

33715 MHD BEARINGS. Dennis C. Kuzma (General Motors Technical Center, Warren, Mich.). Machine Design, 36: No. 10, 206-10(Apr. 23, 1964).

The principles and merits of MHD bearings (bearings in which liquid metal is held or moved between the moving surfaces by MHD effects) are summarized, together with some bearing configurations and their properties. (D.C.W.)

33716 AN AUTOMATIC SAMPLE CHANGER FOR α-, β- AND γ-ACTIVE SOURCES. C. J. Astill, T. A. Eastwood, D. A. S. Walker, and E. E. Wuschke (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instr. Methods, 27: 221-8(May 1964).

A sample changer with a turntable that accommodates twelve uncovered, solid sources for α- or soft β-particle counting in a windowless, gas-flow counter is described. The turntable movement was designed to position the sources accurately beneath the counter. A pneumatic jack unit raises the source and seals it to the counter so that entrapped air can be displaced by the counting gas during a flushing period that precedes the counting period. A second position is provided for a detector of a different type, an end-window β-particle counter or a NaI(Tl) crystal, for example. An absorption curve can be obtained automatically with an end-window counter by placing the source on a shelf below the turntable and absorbers in the turntable. Sources can be counted for a selected time or until a selected number of counts accumulates, whichever occurs first. Timing is done by a tuning fork oscillator. The turntable position number, accumulated count, duration of count period and elapsed time from an arbitrary zero are recorded at the end of each count cycle by an electric typewriter and/or tape punch. (auth)

33717 INSULATION FOR 11-kv 280-kg PULSED MAGNET. J. D. Milne, R. Sheldon, K. D. Srivastava, and M. N. Wilson (National Inst. for Research in Nuclear Science, Chilton, Eng.). Rev. Sci. Instr., 35: 1229-30(Sept. 1964).

The development of interturn insulation for pulsed-coil magnets to extend their range of operation is discussed. Glass fibers impregnated with epoxy resins proved satisfactory for a beryllium–copper alloy coil with a peak field of over 280 kG at an operation voltage of 11 kev. The method of fabrication is described. (C.E.S.)

33718 APPLICATION OF A DIAPHRAGM VALVE FOR SAFE GLASS BLOWING ON APPARATUS CONTAMINATED WITH RADIOACTIVE OR TOXIC MATERIALS. P. S. Rudolph (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 35: 1237(Sept. 1964).

A diaphragm valve was modified to provide a safeguard in glass blowing on a system contaminated with radioactive or toxic materials. The valve has the properties that it can be actuated by the breath using cylinder gas for the actual blowing, that no gas from the system can leak back into the mouth of the operator or into the room, that it allows for pressure release in the glass-system line as soon as activation of the diaphragms ceases, and that the downstream pressure is in a 1:1 ratio to pressure applied by the breath. (C.E.S.)

33719 POWER SYSTEM FOR A MANNED EARTH ORBITAL SPACE STATION. M. Furrow, Jr. and J. M. Boze, III (Chrysler Corp., Huntsville, Ala.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-451, 7p. $1.00. (CONF-600-29)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The power requirements for communications, lighting, experiments, life support systems, temperature control, and stabilization were determined, and power profiles were obtained. A power system using a combination of reactor dynamic and solar photovoltaic systems was evaluated and determined to be feasible. (D.C.W.)

33720 ELECTROSTATIC GENERATORS IN SPACE POWER SYSTEMS. Dominique Gignoux (Cosmic Inc., Washington, D. C.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-450, 7p. $1.00. (CONF-600-30)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The operating principles of electrostatic generator are summarized, and the features of the single-capacitor generator (equivalent to an all-metal, variable capacitor) and the oblique field generator, which uses insulating and semiconducting dielectric materials, are analyzed. A brushless version of the second generator which seems to be most promising for space power systems is then described. (D.C.W.)

33721 SILENT MERCURY RANKINE CYCLE POWER SYSTEM. Donald R. Snoke and Gene L. Mrava (Thompson Ramo Wooldridge Inc., Cleveland). New York, Society of Automotive Engineers, Inc., 1964, Preprint 883D, 9p. $1.00. (CONF-610-2)

From Society of Automotive Engineers, Inc. Summer Meeting, Chicago, June 1964.

A system is described which converts heat from burning hydrocarbon fuels into electrical power through a hermetically sealed mercury Rankine cycle. The 3-kwe unit weighs 125 lb and has a fuel consumption of 6.35 lb/hr. The system features inaudibility at 100 ft with a low ambient noise level. (D.C.W.)

33722 IMPROVEMENTS IN MECHANICAL REMOTELY-ACTUATED MANIPULATORS. (to Saint-Gobain Nucleaire). British Patent 963,930. July 15, 1964. Priority date Jan. 10, 1961, France.

A mechanical manipulator having seven degrees of freedom is designed for working in a "hot" enclosure. The manipulator effects the movements by means of rotation of members which pass in a sealed manner through the wall of the enclosure. The control of the opening and closing of the gripper, of the rotation and elevation of the gripper, and of the azimuthal movement is described. (D.L.C.)

33723 MANIPULATOR ARM PARTICULARLY FOR NUCLEAR REACTORS. Horst Hermann (to Communaute Europeenne de l'Energie Atomique (EURATOM)). British Patent 963,961. July 15, 1964. Priority date Jan. 23, 1962, France.

A manipulator system is designed which can be extended to considerable length such as in reactors, and then retracted when not in use to a coiled condition which takes up a minimum of space. The sytem comprises two chain-like flexible assemblies arranged to interlock with each other to form a fully rigid arm. An apparatus for coiling and uncoiling the assemblies is described in British Patent 963,962. (D.L.C.)

33724 MANIPULATOR APPARATUS. Horst Hermann (to Communaute Europeenne de l'Energie Atomique (EURATOM)). British Patent 963,962. July 15, 1964. Priority date Jan. 23, 1962, France.

An improved manipulator apparatus for use above a reactor core is designed which includes an extensible-retractable manipulator arm. The arm comprises a pair of flexible chain-like assemblies locked together to form a rigid arm in the extended position, and released from

each other in the retracted position. Thus, the arm requires relatively little space for stowage. The arm is also described in British Patent 963,961. (D.L.C.)

33725 IMPROVEMENTS RELATING TO STORAGE MEANS FOR RADIOACTIVE FUEL ELEMENTS. Peter Leslie Gulliver and John Millar Daly (to Babcock & Wilcox Ltd.). British Patent 965,751. Aug. 6, 1964. Filed Nov. 27, 1959.

A plant is designed for the storage of irradiated fuel elements in water whose radioactivity may be controlled. The plant comprises a container for submerging the fuel elements in water, means for adding NaOH to the water, and means for circulating the water from the container through ion exchange means for removing radioactive cations and corrosive anions from the water. Means is also provided for removing Na_2CO_3 from the water. Two different embodiments of the plant are described. (D.L.C.)

33726 IMPROVEMENTS IN OR RELATING TO PNEUMATICALLY-CONTROLLED GRIPPING TONGS. Rene Guilloteau (to Commissariat à l'Energie Atomique). British Patent 966,644. Aug. 12, 1964. Priority date May 2, 1961, France.

A pneumatically controlled gripping tong is designed so that it can be disassembled rapidly for replacement of any damaged part. The tong is of the type comprising two jaws articulated around a common spindle, a piston, and a device for retracting the piston to the open position of the jaws. (D.L.C.)

33727 REVERSIBLE ELECTROMAGNETIC FLUID PUMP. Henry Heyman (to U. S. Atomic Energy Commission). U. S. Patent 3,141,413. July 21, 1964.

A reversible electromagnetic fluid pump is described in which a coil rotatably supported on an elongated pole piece and in which the coil and the duct are provided with accurately spaced terminals, so that rotation of the coil from one terminal position to the other results in reversal of current through the coil, but not through the duct. (AEC)

33728 RADIOACTIVE SOURCE HOUSING WITH REMOTELY OPERATED SHUTTER. John S. Macintyre (to Lab. for Electronics, Inc.). U. S. Patent 3,141,976. July 21, 1964. Filed Apr. 18, 1961.

A source housing having a remotely operated shutter and adapted to traverse a predetermined scanning path is described. Shutter actuation is by mechanical linkage between the remote actuating point and the source housing. (D.C.W.)

Heat Transfer and Fluid Flow

Refer also to abstract 35198.

33729 (ACNP-64027) INVESTIGATION OF VAPOR VOLUME FRACTION AND SLIP VELOCITY UNDER THE EURATOM PROGRAM. Quarterly Progress Report, April 1–June 30, 1964. Kenneth F. Neusen and Mark Healy (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). July 15, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1272. 29p. (EURAEC-1137)

The range of parameters investigated was expanded to include data at 10 and 20 fps superficial liquid velocities and 70% average void fractions. Manometer and gamma attenuation techniques for determining void fraction continued to agree at liquid velocities of 2.5 fps or less but wide divergence was noted at 10 and 20 fps. A flow model which includes a liquid film on the pipe wall was shown to be an improvement over the simple exponential model in predicting void profiles. It was noted that average void fraction in the test section was affected by the steam generator tube sheet just upstream of the test section inlet. (auth)

33730 (AERE-R-4352) HEAT TRANSFER TO MIXTURES OF HIGH PRESSURE STEAM AND WATER IN AN ANNULUS. PART VI. A PRELIMINARY STUDY OF HEAT TRANSFER COEFFICIENT AND HEATER SURFACE TEMPERATURE AT HIGH STEAM QUALITIES. A. W. Bennett, H. A. Kearsey, and R. K. F. Keeys (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). June 1964. 18p.

Measurements of heat transfer coefficient near the exit of an annular test section showed the transition from "fast" to "slow" burnout to be a sharply defined point. At a mass flowrate of 0.6×10^6 lbs ft^{-2} hr^{-1}, it occurred at 75 per cent exit quality at 500 psia and at 82 per cent exit quality at 1000 psia. In the "slow burnout" region, the burnout detector was found to operate at an excess temperature of approximately 100°F. In the post burnout region, the experimental heat fluxes necessary to give a particular surface temperature were up to 40 per cent lower than that to be expected from the steam alone, assuming thermal equilibrium. This suggested that most of the heat transferred was used in superheating the steam rather than in evaporating the water. (auth)

33731 (ANL-6869) APPLICATION OF ELECTRON-BOMBARDMENT HEATING FOR BOILING LIQUID METALS. R. E. Holtz (Argonne National Lab., Ill.). Mar. 1964. Contract W-31-109-eng-38. 16p.

The problem of obtaining a curve of the heat flux vs temperature difference for boiling liquid metals is discussed. Various heating techniques are discussed, with special emphasis given electron-bombardment heating. It is shown that electron-bombardment heating will supply high uniform heat fluxes to liquid metals at high temperatures. (auth)

33732 (EURAEC-1086) A VOLUME DISPLACEMENT METHOD FOR THE MEASUREMENT OF THE LIQUID VOLUME FRACTION IN TWO-PHASE ADIABATIC FLOW. Topical Report No. 13. P. Alia, L. Cravarolo, A. Hassid, E. Pedrocchi, and M. Silvestri (Centro Informazioni Studi Esperienze, Milan). Feb. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 060-61-7-RDI. 54p. (CISE-R-92)

A description is given of a procedure which has been developed for the determination of the overall liquid volume fraction (hence of the overall slip ratio and mean density) in two-phase (gas + liquid) mixtures in adiabatic flow. An error analysis of the results is also presented. Systematic experiments were carried out under the following conditions:

Flow:	vertical upward (in annular-dispersed regime)
Geometry:	round conduits 1.5 and 2.5 cm ID
Fluids:	gas phase: argon
	liquid phase: {water / ethyl alcohol}
Gas flow rate:	15–100 g/cm² sec
Liquid flow rate:	20–200 g/cm² sec
Temperature:	18–20°C
Pressure:	up to 22 kg/cm²

Experimental data are reported. (auth)

33733 (EURAEC-1127) THE STEADY-STATE AND DYNAMIC BEHAVIOUR OF A BOILING WATER REACTOR. Quarterly Progress Report No. 13, January 1–April 1, 1964. (Eindhoven, Netherlands. Technische Hogeschool). June 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract P-313. 14p. (WW016-R62)

A description is given of work done on the steady-state and dynamic behavior of a boiling water reactor. Attention is paid to the analysis of the experimental results and the physical description of the observed phenomena. (auth)

33734 (GEAP-4646) TRANSITION BOILING HEAT TRANSFER PROGRAM. Quarterly Progress Report No. 6, April–June 1964. E. P. Quinn (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT (04-3)-189. 24p. (EURAEC-1141)

Transition boiling data were taken with an improved flow loop to explore the influence of loop characteristics on rod temperature fluctuations. The transition region was found to be much smaller than for comparable conditions with a different loop. Also the amplitude and frequency of the temperature oscillations were significantly less than before. These results indicate that loop characteristic and flow disturbance parameters play a prominent part in governing the transition temperature fluctuations. Additional two-rod transition boiling data are presented. The results include data taken at high wall temperature levels during a demonstration test at low steam qualities and the effect of a change in rod spacing on heat transfer performance. (auth)

33735 (MIT-2079-2) THERMAL CONTACT RESISTANCE (thesis). John Jewett Henry (Massachusetts Inst. of Tech., Cambridge. Heat Transfer Lab.). June 1964. Contract AT(30-1)-2079. 121p.

An analysis is developed to predict the thermal resistance between two surfaces pressed together. The prediction of contact resistance is viewed as a series of three tasks: (1) a thermal analysis of a contact model, (2) a surface analysis to relate the actual geometry of the interface to the contact model, and (3) a deformation analysis to determine the relationship between the actual geometry and the applied load. The thermal analysis used is based on the previous work of H. Fenech and W. M. Rohsenow. Their analysis is reviewed, and some simplifications, applicable to almost all contact situations, are made in order to render it into a more tractable form. The surface analysis is approached by considering the surfaces to be random processes. As a result of this treatment it is seen that surfaces are described by two properties: the surface root mean square (σ) and the root mean square of the surface slope (δ). Through these numbers the interface geometry is related to the contact area ratio (ϵ^2). The final task consists of relating the contact area ratio to the load supported by the interface. Two deformation analyses are described. The case of rough, non-wavy, metallic surfaces is based on the assumption of plastic deformation of the surface asperities, while an "aggregate stiffness" model is hypothesized for the deformation of graphite surfaces. Experimental data were obtained and are compared with prediction of contact resistance as a function of contact load. Some related topics are presented. Of particular importance is a comparison of the predicted values of the number of contacts per unit area and data obtained by a radiographic technique. Also included are a description of the surface analyzer, the result of analogue computer surface analyses, and some considerations of the statistical distribution of surface height. (auth)

33736 (NASA-TN-D-2299) FORCES ACTING ON BUBBLES IN NUCLEATE BOILING UNDER NORMAL AND REDUCED GRAVITY CONDITIONS. Edward G. Keshock and Robert Siegel (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Aug. 1964. 25p.

An experimental study was made of bubble dynamics for saturated nucleate boiling in aqueous-sucrose solutions in normal- and reduced-gravity fields. Results are compared with a previous study that used distilled water. Departure diameters of bubbles in sucrose solutions were found to be gravity independent, while bubbles in distilled water were gravity dependent. Calculations based on the experimental data showed bubble departure in sucrose solutions to be dominated by inertial forces (gravity independent), while bubbles in water were buoyancy dominated (gravity dependent). The rise of bubbles after departure was also observed and analyzed. (auth)

33737 (ORNL-P-18) RECENT STUDIES OF BOILING BURNOUT. W. R. Gambill (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 12p. (CONF-537-3)

From USAEC-EURATOM Conference on Two Phase Flow Problems, Washington, D. C., Apr.-May 1964.

Five studies of critical heat flux in water systems are described: (1) inherent uncertainty in critical heat flux in saturated pool boiling, (2) heat transfer inside horizontal, open-ended heated tubes in a pool, (3) natural-convection burnout of vertical heated channel closed at its bottom, (4) forced-convection burnout with heated twisted tapes, and (5) a swirl-flow forced-convection bulk-boiling loop for studies on water–steam mixtures and twisted tapes. (D.L.C.)

33738 (ORNL-TM-894) SUBCOOLED SWIRL-FLOW BOILING AND BURNOUT WITH ELECTRICALLY HEATED TWISTED TAPES AND ZERO WALL FLUX. W. R. Gambill (Oak Ridge National Lab., Tenn.). June 11, 1964. Contract [W-7405-eng-26]. 20p.

A series of swirl-flow tests was conducted in which all of the heat was generated in twisted-tape swirl generators. This is in contrast to past ORNL swirl-flow tests with twisted tapes, in which ~99% of the heat was generated in the metallic tube wall. In the present study, water from a constant-head tank flowed by gravity at 5 to 8 fps through a vertical 0.27-in.-ID glass tube ~13 in. long, in which was located a resistance-heated, 16-mil-thick A-nickel tape. Tape twist ratios were varied from 2.7 to ∞ inside tube diameters/180-deg twist, inlet water temperatures from 63 to 173°F, and heat fluxes from 0.21×10^6 to 1.20×10^6 Btu/hr · ft^2. The water head above the top of the tube was held at 30.7 in. In all cases, the critical wall superheat increased with decrease of tape twist ratio, whereas the critical heat fluxes for the twisted tapes fell between 93% and 122% of those for flat tapes, maximizing in all cases at a tape-twist ratio of 7 to 10. It is postulated that the deleterious effect of centripetal acceleration with this geometry, which tends to hold the vapor on the heated surface, is compensated in the swirl-flow entrance region by inertial impingement of the liquid onto the tape surface, and along the remainder of the length by a double-vortex secondary flow pattern in the plane normal to the tube wall. The power density of a swirl-flow tube assembly may therefore be significantly increased by generating heat in the twisted tape as well as in the tube wall. (auth)

33739 (RT/ING(64)-5) LA MISURA DELLE FRAZIONI DI VUOTO IN CIRCUITI SPERIMENTALI. (The Measurement of Void Fraction in Experimental Loops). A. Merelli (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Feb. 1964. 30p.

The problem of the void fraction measurement in experimental out-of-pile water loops is considered. After some remarks on the importance of this problem, various measurement techniques are discussed. (auth)

33740 (SC-DC-64-891) TEMPERATURE DISTRIBUTION AND THERMAL STRESSES IN RADIATION-COOLED CIRCULAR CYLINDERS. William E. Putman, Jr. (New Mexico. Univ., Albuquerque. Engineering Experiment Station). 1964. Contract [AT(29-1)-789]. 155p.

Thesis submitted to Univ. of New Mexico, Albuquerque.

This study involves the determination of the transient temperature distribution and thermal stresses in a solid circular cylinder cooled by thermal radiation. The analytical solutions are presented in dimensionless form. Theoretical results are shown for temperature distribution and thermal stresses in the nondimensional form. Certain of these results are given in the dimensional form for the model cylinder used in this investigation. The uranium-zirconium prototype element was thought to be undesirable for this investigation. Therefore, similitude was used to select a model which could be used for the experimental work. A solid, cylindrical, epoxy model was constructed, and thermocouples were embedded in the cylinder to determine the temperature distribution. Strain gages were to be embedded in the cylinder to determine the thermal stresses; however, a gage has not been found which is temperature compensated for the epoxy material. Mechanical equipment was acquired or built for the experimental investigation, and included: a vacuum apparatus; a liquid-nitrogen-cooled heat sink; a collapsible cylindrical heater and shields; the framework to support the model and the heater and shields; and two mylar-coated, chromium radiation shields. This equipment was tested successfully where required. Some of the thermocouples for the experiment were calibrated using two calibration points. The ionization gage in the vacuum system was calibrated at one point using a McCleod gage. A test was set up to determine the emissivity and thermal conductivity of the epoxy material using a small test cylinder made of epoxy and instrumented with thermocouples. The results of this test appeared to be of doubtful use due to uncertainty in the thermocouple readings. The thermocouples require an accurate calibration to improve the experimental results for this test. (auth)

33741 (TID-20603) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report No. 11. (Babcock and Wilcox Co., Barberton, Ohio). Mar. 1964. Contract AT(11-1)-1280. 69p.

The preliminary design for the full-size steam generator is being completed. Design work on the prototype steam generator is in progress. (auth)

33742 DENSITY DISTRIBUTION OVER A MOVING CIRCULAR PLATE IN FREE-MOLECULE FLOW. K. J. Touryan (Sandia Lab., Albuquerque, N. Mex.). AIAA (Am. Inst. Aeron. Astronaut.). J., 2: 559-61(Mar. 1964). (SC-R-64-109)

The free-molecule flow field was calculated on the front side of a moving circular plate including the effect of finite area distribution on the density gradient of the reflected molecules. Calculations were carried out both for diffuse and specular reflections, and the results were compared with those obtained from differential area considerations. (auth)

33743 EXPERIMENTAL STUDY OF CRITICAL BOILING HEAT TRANSFER. V. N. Smolin, V. K. Polyakov, and V. I. Esikov. At. Energ. (USSR), 16: 417-23(May 1964). (In Russian)

Results are presented of a study of critical boiling heat transfer in vertical steam generating pipes under forced flow. Studies were carried out on pipes with internal diameter of 5 to 16 mm at pressures of (49 to 196) $\times 10^5$ newtons/m^2 and mass velocities of 500 to 8000 kg/m^2 sec. Formulas for the calculation of critical heat flow are presented. (tr-auth)

33744 HEAT TRANSFER BETWEEN SEPARATED BUNCHES OF RODS WITH LONGITUDINAL FLOW OF METALLIC SODIUM. V. M. Borishanskii and É. V. Firsova. At. Energ. (USSR), 16: 457-8(May 1964). (In Russian)

Results of a previous study of heat transfer in sodium flow ($Pr \approx 0.007$) between parallel pipes at the vertices of an equilateral triangle arrangement with relative distance $s/d = 1.2$ were correlated with data from an investigation of mercury flow ($Pr \approx 0.02$) in analogous geometry with $s/d = 1.38$ and 1.75. The general criterion formula $Nu = 6 + 0.006\ Pe$ was thus obtained. To test this formula, experiments on sodium flow with $s/d = 1.5$ were carried out. The oxygen content in the sodium at 220 to 270°C ($Pr = 0.0064$) was 0.017% by weight. The velocity of sodium flow was 0.09 to 0.59 m/sec. The numbers Re and Pe varied in the ranges (4.3 to 28) $\times 10^3$ and 28 to 172, respectively. Results of the $Nu = f(Pe)$ variation are given for various values of s/d, for this experiment and the previous measurements. (M.J.T.)

33745 PREDICTION OF PRESSURE DROP DURING FORCED CIRCULATION BOILING OF WATER. J. R. S. Thom (Babcock & Wilcox Ltd., Renfrew, Scotland). Intern. J. Heat Mass Transfer, 7: 709-24(July 1964).

A simplified scheme is given for the calculation of pressure drop during the circulation of a two-phase mixture of boiling water and steam. The method follows that proposed by Martinelli and Nelson, which was extended to include the gravitational term in vertical evaporating tubes. Curves are given from which frictional, acceleration, and gravitational losses can be estimated, provided the outlet quality has been calculated from a heat balance. Data for calculating the pressure drop during the two-phase flow of water and steam along an unheated tube are included. (auth)

33746 LAMINAR FORCED CONVECTION IN RECTANGULAR CHANNELS WITH UNEQUAL HEAT ADDITION ON ADJACENT SIDES. Joseph M. Savino and Robert Siegel (Lewis Research Center, Cleveland). Intern. J. Heat Mass Transfer, 7: 733-41(July 1964).

Temperature distributions are determined analytically for fully developed laminar heat transfer in channels with aspect ratios from 1 to ∞. The channel walls are uniformly heated, but the heat flux on the short sides in an arbitrary fraction between 0 and 1 of the heat flux on the broad sides. For all cases, the wall temperatures are compared on the basis that the total heat transferred per unit channel length is maintained at a fixed value. The poor convection due to the low velocities in the corners and along the narrow walls always caused the peak temperatures to occur at the corners. The lowest peak temperatures were found when all the heating took place at only the broad walls rather than when heating was partly distributed to the short sides. This results from the fact that, when four sides are

heated, more energy is being supplied to the low velocity corner regions. For heating at only the broad walls, the corner temperature decreases rapidly as the aspect ratio is increased to about 10 and insignificantly thereafter. In the limit of infinite aspect ratio, the wall temperature distribution does not approach a constant as is the case for infinite parallel plates. (auth)

33747 LAMINAR, TURBULENT, AND TRANSITION GAS FLOW IN POROUS MEDIA. E. Creutz (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 20: 28-44(Sept. 1964).

The flow rates of gases at room temperature through various porous materials were measured for large ranges of average pressure and pressure difference across the samples, such that $P\Delta P$ for a given sample varies by factors as large as 10^6. The rates are proportional to $(P\Delta P)^\gamma$, where γ decreases from 1 to 0.5 as the flow increases, and γ for a given medium is a function of an effective Reynolds number only, independent of the gas used. An equation expressing all the data, including those for transition flow, was obtained and transformed into a dimensionless equation. The dimensionless equation also applies to some data obtained elsewhere on flow through various porous metals and beds of granular solids. Mean hydraulic radii, and effective numbers of pores and friction and surface-roughness factors for the samples considered are given. (auth)

33748 DYNAMICS AND HEAT TRANSFER IN THE VON KÁRMÁN WAKE OF A RECTANGULAR CYLINDER. Francis H. Harlow and Jacob E. Fromm (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 7: 1147-56(Aug. 1964). (LADC-6299)

A numerical method was used to solve completely the full equations for the motion of a viscous, heat-conducting, incompressible fluid flowing through a channel past a rectangular cylinder. The dynamics of the unsteady flow were made visible by means of a number of different types of contour plots, and selected ones are presented and discussed to illustrate various newly discovered features of the von Kármán vortex street. In addition, the heat transfer was measured from the heated rear of the cylinder to the colder fluid, with data presented in the form of Nusselt number correlated with Reynolds number. Corrections are derived for blockage, and Prandtl number scaling is discussed. (auth)

33749 MECHANISM OF PARTICLE COLLISION IN THE ONE-DIMENSIONAL DYNAMICS OF GAS-PARTICLE MIXTURES. Frank E. Marble (California Inst. of Tech., Pasadena). Phys. Fluids, 7: 1270-82(Aug. 1964).

A theory is developed for the one-dimensional flow of a gas, containing solid particles of two different sizes, in which the effect of particle collisions is accounted for as well as the interaction between the particles and the gas. It is assumed that the particles behave as smooth elastic spheres, that they follow the Stokes drag law and exchange heat with the gas at a Nusselt number of unity. It is shown that there exists a range of parameters which provides that the viscous flow fields about each particle do not interfere during collision, and the random velocities imparted by one collision are damped before either particle suffers another collision. Using the assumption of small particle slip, the one-dimensional flow problem is solved explicitly up to first order terms in the small slip. It is found, of course, that the tendency of collisions is to cause the two particle-slip speeds to have more nearly the same value than they would in the absence of interparticle collision. It appears that, although the physical assumptions restrict the magnitude of the interparticle forces, the model does provide the proper limit for very strong particle interaction and can conceivably be applied in this range also without gross error. (auth)

33750 PRECISE MEASUREMENT OF FLOW RATES WITH RADIOISOTOPES. D. E. Hull (California Research Corp., Richmond). 13p. (CONF-179-4)

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

Two essential changes were made in the total-count method for measuring flow rates with radioisotopes. The first change involves the use of a scintillation counter instead of a Geiger counter. In the second, a sample is collected during the interval in which all of the infused tracer passes the sampling point and is counted as long as necessary. The first change removes the limitation on counting speed, the second on counting time; the combination makes it possible to record upward of one million counts per observation with a potential accuracy of 0.1%. The principle of the new total-sample method was demonstrated in the measurement of water flowing through a heat exchanger. Cobalt-60, in the form of sodium cobalticyanide, was used as the tracer. (P.C.H.)

33751 NERVA THERMAL AND FLUID FLOW ANALYSIS. L. C. Moore, E. Gordon, and B. L. McFarland (Aerojet-General Corp., Azusa, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-392, 10p. $1.00. (CONF-600-5)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

A computer program developed for fluid flow and thermal analyses on the NERVA system is discussed. Operations, procedures and truncation errors are considered, and six experiments made with the program are outlined. (D.C.W.)

33752 HEAT TRANSFER STUDY FOR ARC JET ENGINES. PART A. G. L. Cann, G. L. Marlotte, R. A. Moore, and R. D. Buhler (Electro-Optical Systems, Inc., Pasadena, Calif.). 88p. (CONF-102-38)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The energy transfer rate from ammonia and hydrogen plasmas flowing in a duct was studied analytically and experimentally. The plasma was produced in an arc jet and fed into a cylindrical water-cooled channel, in which the heat transfer was measured. Measurements were made in both continuous and segmented channels over a wide range of gas pressure and enthalpy. Argon and helium were used initially to calibrate the single-tube channel. The experimental data are plotted as Nusselt number vs Reynolds number. The slopes of the curves are approximately the same for all of the gases. The absolute values of the plotted data do not correlate from one gas to another; a tentative explanation is proposed. (auth)

33753 MODERN NUCLEAR TURBINE DESIGN. E. H. Miller (General Electric Co., Schenectady, N. Y.). 13p. (CONF-504-10)

From American Power Conference 26th Annual Meeting, Chicago, Apr. 1964.

The basic designs developed for 1800-rpm turbines for reheat and nonreheat steam cycles are presented, with consideration of designs for specific capacities. Design requirements and the bases for some design decisions are also summarized. (D.C.W.)

33754 HEAT EXCHANGER. C. R. Binner and C. W. Hammond (to U. S. Atomic Energy Commission). U. S. Patent 3,139,927. July 7, 1964.

A heat exchanger is described in which liquid metal heated by a reactor supplies additional heat to heated air passing from an air compressor to a jet engine. The annular heat exchanger surrounds a drive shaft extending between the compressor and the jet engine and built in semicircular sections to facilitate assembly about the drive shaft. (AEC)

Materials Testing

Refer also to abstracts 34223, 35207, and 35208.

33755 THERMALLY INDUCED VIBRATIONS OF CONCENTRIC THIN SPHERICAL SHELLS. Arthur L. Austin (Univ. of California, Livermore). Nucl. Sci. Eng., 20: 45-52(Sept. 1964). (UCRL-7402(Rev.I))

The dynamic response of a set of concentric spherical shells in which the inner shell only is subjected to rapid, uniform, internal heat generation, was determined. The maximum number of shells chosen for analysis was three; however, the method is general and may be applied to systems containing as many concentric shells as desired. The results are presented in parametric form for the stresses in each shell and their dependence upon the material properties. In most reactor-design problems it is desired to maintain the integrity of any system; hence, it is assumed that the inner, heated shell always remains elastic. This represents the extreme stress condition, and may cause yielding of the outer shells. For constraint of the inner shell, the dynamic stresses are obtained for elastic motion and for plastic flow of the outer shell at constant stress. The special case of instantaneous heating and the effect of composite material properties upon stress amplitudes are considered in detail to provide useful design formulas. (auth)

33756 COMPRESSED GAS GUN FOR CONTROLLED PLANAR IMPACTS OVER A WIDE VELOCITY RANGE. S. Thunborg, Jr., G. E. Ingram, and R. A. Graham (Sandia Corp., Albuquerque, N. Mex.). Rev. Sci. Instr., 35: 11-14 (Jan. 1964). (SC-R-731)

A compressed gas gun capable of accelerating precisely aligned, flat-faced projectiles over a wide velocity range is described. Predetermined reproducible velocities may be achieved between 150 and 5700 ft/sec with an angular misalignment between the impacting surfaces as small as 1.3×10^{-4} rad. The impact occurs in a vacuum with pressures as low as 10^{-4} mm Hg. The gun has an inside diameter of $2\frac{1}{2}$ in., a length of 100 ft, and uses either air or helium at pressures as high as 5000 psi. (auth)

33757 EVALUATION OF THE ERRORS IN THE DETERMINATION OF THE LEAKAGE RATE DURING LEAK TESTING OF REACTOR CONTAINERS. Arturo Calori (Comitato Nazionale per l'Energia Nucleare, Rome) and Aldo Persano. Riv. Ing. Nucl., 2: 297-303(Jan.-Apr. 1964). (In Italian)

The evaluation of the errors made in the determination of the leak rate during leak testing of reactor containers is discussed. The limits of validity of the results of such measurements are indicated. (J.S.R.)

Protective Structures

33758 IMPROVEMENTS IN OR RELATING TO SHELTERS. Edwin Jacobsen, Jr. and Worthington Thompson. British Patent 964,098. July 15, 1964. Priority date Mar. 4, 1960, United States.

A strong bomb shelter is designed which is simple to construct. The shelter comprises a shallow concave base of semi-elliptical section with a peripheral rim, and a semicircular dome of rigid sheet material fitting over the base. The shelter is covered with earth to the required depth. Ventilation and door means are provided. (D.L.C.)

Vacuum Engineering

33759 (AD-427830) EFFECTS OF ELECTRON-SURFACE INTERACTION IN IONIZATION GAUGES. W. C. Schuemann, J. L. de Segovia, and D. Alpert (Illinois. Univ., Urbana. Coordinated Science Lab.). Aug. 1963. Contract DA-36-039-AMC-02208(E). 21p. (R-180)

A systematic study of an anomalous nonlinearity in ionization gages was made, indicating the magnitude of possible errors in ionization gage readings. The errors were particularly enhanced after oxygen was introduced into the system. Evidence was provided for the interpretation of the effect as due to dissociative ionization by electron impact at the grid surface. At low values of grid current, there is an enhanced rate of production of such ions accompanied by a reduced rate of collection in a Bayard-Alpert gage. The anomalous readings in ionization gages can be greatly reduced by thorough outgassing of the grid by electron bombardment. Thereafter, operation at electron currents of 5 mamp or greater gives reliable readings. In the presence of O_2 a number of other effects may be present to give erroneous ionization gage readings; in particular, the composition of the gas may be altered, both by chemical reactions at the hot filament and by electron bombardment of adsorbed gases. Studies of these effects have brought valuable insight into very interesting physical and chemical processes which take place not only in ionization gages and mass spectrometers, but wherever electrons are incident on solid surfaces. (auth)

33760 SPUTTER-ION PUMPS WITH THERMIONIC ELECTRON INJECTION. E. H. Hirsh (Weapons Research Establishment, Salisbury, South Australia). J. Sci. Instr., 41: 426-30(July 1964).

Experimental results are presented on sputter-ion pumps of both Penning and magnetron configuration, into which thermionic electrons are injected from an auxiliary source. Empirical laws are established connecting the pumping speed, magnetic field strength, anode potential, and pumping current. It is found that the injection of thermionic electrons allows the use of considerably lower magnetic field strengths and anode voltages than are required in a cold-cathode pump of the same pumping speed. The results show that as an ion pump the Penning structure is a more efficient electrode arrangement than a magnetron geometry. (auth)

33761 PROBLEMS AND NEW DEVELOPMENTS IN THE ULTRA-HIGH VACUUM FIELD. Gerhard Kienel (W. C. Heraeus GmbH, Hanau, Ger.). VDI (Ver. Deut. Ing.) Z., 106: 777-86(June 1964). (In German)

A brief historical outline is given of the general principles of ultrahigh vacuum technology. The developments in the production and measurement of extremely low pressures are reviewed. Improvements in diffusion pumps, getter ion pumps, molecular pumps, and cryopumps are emphasized. A series of ionization vacuum meters with independent and dependent discharge that are suitable for the pressure range below 10^{-10} torr are described. The

techniques and problems in the construction and start-up of ultrahigh vacuum installations are reviewed. The single-walled and double-walled construction methods with intermediate vacuum are compared. (tr-auth)

33762 VACUUM TECHNOLOGY. Windsor S. Spinks. Englewood, N. J., Franklin Publishing Company, Inc., 1964. 134p. $3.60.

The problems and techniques associated with the production of high vacua are discussed. No previous knowledge of vacuum techniques is assumed, and the terms or principles used are defined. Seven chapters are included. Topics discussed are pressure, vacuum measurement, vacuum creation, vacuum systems, pumping speeds, vacuum leaks and leak detection. Useful data and glossary of terms used in vacuum technology are given in an appendix. (L.B.S.)

33763 APPARATUS FOR THE IRRADIATION OR VACUUM-COATING OF SPECIMENS. Siegfried Buesch, Rudolf Hatschek, and Franz Pischinger (to Hans List). U. S. Patent 3,140,393. July 7, 1964. Priority date Mar. 22, 1961, Austria.

An apparatus is described for the irradiation or vacuum-coating of specimens, and comprises a treatment chamber, a supporting frame, and a rotatable and tiltable specimen table. (R.E.U.)

33764 METHOD FOR MAINTAINING VERY HIGH VACUUM IN A SYSTEM. R. E. Clausing (to U. S. Atomic Energy Commission). U. S. Patent 3,140,820. July 14, 1964.

A vacuum system is described for handling large quantities of hydrogen or isotopes thereof at very low pressures, using a getter pumping arrangement. (AEC)

GEOLOGY AND MINERALOGY

General

Refer also to abstract 33594.

33765 (AD-437784) INVESTIGATION OF AUDITORY DISCRIMINATION OF SEISMIC SIGNALS FROM EARTHQUAKES AND EXPLOSIONS. Final Report. G. E. Frantti and L. A. Levereault (Michigan. Univ., Ann Arbor. VELA Seismic Information Analysis Center). Apr. 1964. Contract AF49(638)-1079. 39p.

Magnetic tape recordings of short-period seismic signals from approximately 200 earthquakes and explosions were time-compressed by a factor of up to 512 to shift seismic frequencies to the audible range. These seismic data include the inhomogeneities introduced by substantial variations in the locations of sources and receivers (worldwide), propagation path length (32 to 7000 km), and source magnitude (M = 0.5 to M = 6.5). Subjects were trained with a representative set of the "seismic sounds." Auditory experiments were conducted to determine the ability of the human auditory system to distinguish between seismic signals from earthquakes and explosions. The results of the experiments suggest that a trained listener can identify approximately two thirds of the seismic sounds presented. (auth)

33766 (HNS-1229-47) SPATIAL DISTRIBUTION OF RADIOACTIVE MATERIALS AROUND THE CAVITY OF AN UNDERGROUND NUCLEAR DETONATION. Edward J. Lynch (Bradberry (Carroll E.) & Associates, Los Altos, Calif.). Apr. 1, 1964. For Hazleton-Nuclear Science Corp., Palo Alto, Calif. Contract AT(29-2)-1229. 78p.

The first step in the study of the contamination of groundwater by underground nuclear explosions is the determination of the probable location of hazardous radionuclides around the shot point. An analysis is presented of this problem for contained explosions. Consideration was given to the subsurface stresses involved, the direction and rate of fracture propagation, the injection of melted rock and cavity gas into the cracks, and the effect of chimney collapse. The calculations, based on a set of conditions similar to the Rainier event, indicate that almost all of the radioactivity will be found in the lower part of the collapse chimney; about ten per cent of the ^{90}Sr and ^{137}Cs will be found in fractures at distances up to three cavity radii from the shot point. In the course of the investigation, several interesting phenomena were uncovered which could have important safety implications under certain circumstances. (auth)

33767 ON THE INFLUENCE OF INCLUDING ROCKS ON THE ISOTOPIC SULFUR COMPOSITION OF ORE SULFIDES. A. P. Vinogradov and L. N. Grinenko. Geokhimiya, No. 6, 491-9(June 1964). (In Russian)

Sulfides from copper–nickel deposits in Talnakh and Gora Tshornaya showed a considerable, 0.91–0.94% in the average, enrichment in the ^{34}S isotope in comparison with the standard meteoritic sulfur. The enrichment in ^{34}S of sulfides from ore-bearing intrusions of the Norilsk district is accounted for by the magma assimilation by these sulfur intrusions of gypsum-anhydrite strata, being interbedded among including rocks. In the ore mineralization of the Dovyren massif (folded region near the lake Baikal) where in the section of including rocks sedimentary sulfates are absent, sulfides are slightly enriched in the ^{34}S isotope in comparison with the sulfur of meteorites, average to 0.18%. (auth)

33768 ANCIENT GRANITE GNEISS IN THE BLACK HILLS, SOUTH DAKOTA. R. E. Zartman, J. J. Norton, and T. W. Stern (Geological Survey, Washington, D. C.). Science, 145: 479-81(July 31, 1964).

Granite gneiss, with an age of approximately 2.5 billion years, in the Black Hills, South Dakota, provides a link between ancient rocks in western Wyoming and Montana and in eastern North and South Dakota and Minnesota. The discovery suggests that early Precambrian rocks covered an extensive area in northcentral United States and were not restricted to several small nuclei. (auth)

Natural Radioactivity and Fallout

33769 (NP-14091) RADIOKHIMICHESKAYA METODIKA MASSOVOGO KONTROLYA SODERZHANIYA STRONTSIYA-90 V PRESNYKH VODOEMAKH. (Radiochemical Method for Large-Scale Observation of the Strontium-90 Content in Fresh-Water Reservoirs). G. A. Sereda and Ts. I. Bobovinkova (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 12p.

A simple method is suggested for determining ^{90}Sr concentration in fresh water using precipitation with calcium salts. Experiments indicated that additions of 12 g of ammonium carbonate and 100 ml 10 N ammonium hydroxide completely precipitate the calcium. The method permits the precipitation of carbonates, with uranium and potassium remaining in the settling basin, while ^{89}Sr, ^{90}Sr, ^{141}Ce, ^{144}Ce, ^{95}Zr, ^{95}Nb, ^{140}Ba, etc. are precipitated with calcium carbonates. The precipitation is followed by the ordinary radiochemical process of dissolution in acid and rare earth separation on iron hydroxide. Yttrium-90 daughter products are precipitated later as yttrium oxalate. The relative order of error in strontium separation from yttrium is ±5%. A more improved method permits the precipitation of Sr and Ca directly upon separation from other radioactive impurities. With this method the β spectrum of the carbonate precipitate is measured immediately and after 12 to 15 days. The accumulated ^{90}Y verifies the content of ^{90}Sr. (R.V.J.)

33770 (SCPRI(S)-99) ETUDE DES POUSSIERES DE HAUTES ACTIVITES ISOLEES DANS CERTAINES RETOMBEES SUR LE TERRITOIRE FRANCAIS EN 1962–1963. (Study of High-Activity Dusts Isolated in Fallout on the French Territory During 1962–63). P. Pellerin, J. P. Moroni, and J. De Zertucha (France. Service Central de Protection contre les Rayonnements Ionisants, Paris). 8p.

A systematic autoradiography of air-filter samplers proved the presence of isolated dusts of very high activity (several thousand picocuries). The detailed analysis of these dusts shows that they are often formed of almost pure fission products. Zirconium-95–niobium-95 is the most frequent, but, in a certain number of cases, ruthenium 103 is evident. (auth)

33771 FISSION PRODUCT PRECIPITATION FROM THE ATMOSPHERE IN DEBRECEN, HUNGARY, DURING 1961 AND 1962. A. Szalay and Á. Kovách (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 16: 321-6(1964).

The results of measurements carried out in the years 1961 and 1962 to determine the radioactivity due to fission products of precipitation from the atmosphere in Debrecen are given. The relation between the specific activity and the quantity of precipitation is treated and conclusions are drawn as to the variation of the radioactive contamination of the surface of the Earth. Based on the measurement of the decay of samples, the activity measured in the individual periods is approximately assigned to the series of atomic weapon tests which began in the autumn of 1961. (auth)

33772 6TH REPORT OF THE FEDERAL COMMISSION FOR CONTROL OF RADIOACTIVITY, SUBMITTED TO THE FEDERAL COUNCIL FOR THE YEAR 1962. P. Huber. Bull. Eidgenoess. Gesundh., Beil. B, No. 4, 1-84(Nov. 1962). (In German and French). (A/AC.82/G/L.894)

The new activities of the Commission include the determination of ^{137}Cs and ^{131}I in milk, grass, and hay, calcium concentrations in soil, grass, and hay, and radioactivity of foodstuff and beverages. The methods used for these determinations are given. Measurement results are tabulated and discussed for air, precipitations, cistern water, sludge, surface and ground waters, grass, hay, soil, ^{90}Sr in foodstuff, and ^{90}Sr in human bone. (J.S.R.)

33773 THE VARIATION OF POTENTIAL GRADIENT WITH ALTITUDE ABOVE GROUND OF HIGH RADIOACTIVITY. E. T. Pierce and A. L. Whitson (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res., 69: 2895-98(July 15, 1964).

During the summer of 1962, the potential gradient was measured at Mercury, Nevada, as a function of height above ground level. At the earth's surface the value was +30 v/m; this rose steadily with altitude to a maximum of +110 v/m at a height of about 1200 m. The interpretation of these results suggests that the surface gamma activity for areas adjacent to atomic weapon test sites in Nevada is perhaps ten times the normal background. (auth)

33774 DEPENDENCE OF THE SURFACE HEAT FLOW ON THE RADIOACTIVITY OF THE EARTH. Gordon J. F. MacDonald (Univ. of California, Los Angeles). J. Geophys. Res., 69: 2933-46(July 15, 1964).

It is well known that the earth's surface heat flow is in approximate balance with the heat production in an earth of chondritic composition. The ratio of K/U in crustal rocks and peridotite, dunite, and eclogite is about 10^4, in contrast to the ratio in chondrites of about 7.5×10^4. The calculations described show that earth models having a U concentration 3 or 4 times that observed in meteorites and with $K/U = 10^4$ yield the observed heat flow, provided that the initial temperature was of the order of 1000°C or less. In the models, the ratios of K/U and Th/U are assumed constant throughout the earth and equal to 1×10^4 and 3.7, respectively. Three radial distributions of radioactive material are studied: uniform distribution to mantle, oceanic structure with radioactive material in the upper 1500 km and a concentration above 465 km, and continental structure with radioactive material above 1500 km and a marked concentration in the upper 45 km. The oceanic and continental models give the observed heat flow, provided that the average U concentration of the mantle lies between 4 and 5×10^{-8} g g^{-1} and the initial temperature at depth was 1000°C. An average mantle concentration of U of about 5.5×10^{-8} g g^{-1} will produce melting in the upper mantle and a heat flow in excess of that observed. With these structures, the calculations clearly show that the present heat flow implies melting at depth unless the thermal conductivity increases substantially with depth. (auth)

33775 RADIOACTIVE FALLOUT FROM CRATERING SHOTS; REMARKS ON PAPER BY M. D. NORDYKE AND W. WRAY, CRATERING AND RADIOACTIVITY RESULTS FROM A NUCLEAR CRATING DETONATION IN BASALT. E. A. Martell (National Center for Atmospheric Research, Boulder, Colo.). J. Geophys. Res., 69: 3043-6(July 15, 1964).

Incompletions in the previously presented (NSA 18: 13993) assessment of the radioactivity release in the Danny Boy event are discussed, together with inaccuracies in the conclusions drawn on fallout from excavation shots. A reply by Nordyke is also included. (D.C.W.)

33776 THE CONTRIBUTION TO Sr^{90} DETERMINATION IN FALLOUT AND SOIL IN WESTERN SLOVAKIA. Stefan Csupka, Maria Petrasova, and Jozef Carach. Jaderna Energie, 10: 196-9(June 1964). (In Czech)

The accumulation of ^{90}Sr in soil in the period of 1962–1963 in chosen localities of Western Slovakia was investigated. The ^{90}Sr activity in soil during the running year has not shown marked differences. (P.C.H.)

33777 STRONTIUM EXCHANGE CHARACTERISTICS OF SOILS FROM THE OGOTORUK CREEK WATERSHED IN ALASKA. J. L. Mortensen, E. C. Marcusiu, and N. Holowaychuk (Ohio Agriculture Experimental Station, Columbus). Ohio J. Sci., 63: 225-31(1963).

Surface organic layers of 10 unclassified soils were investigated. They were air-dired and crushed to pass a 2 mm sieve. Six soils were classified as organic, the content being determined by dry combustion. Soil reaction (P^H) varied from 3.9 to 5.8 as shown by a glass electrode, using a soil-water ratio of 1 to 3. The cation exchange capacity was determined by chromatography. The exchange of barium and strontium ions for hydrogen ions was studied in 4 representative soils. Hydrogen ions were more readily replaced by strontium than by barium. It is apparent that the soils studied, especially those having high exchange capacity and base status, are capable of adsorbing considerable quantities of ^{90}Sr (^{90}Y). Leaching waters from the more acidic soils release strontium more readily into the drainage waters than in the case of less acid soils. The leaching of fallout Sr from acidic organic soils may occur in a relatively short period of time. Fission product ecology in soils of the area is apparently governed largely by pH and cation exchange. (Excerpta Med., Sect. XXIII, 1: No. 6 (June 1964))

33778 RADIOSTRONTIUM IN SOIL AND PLANTS IN WARSAW DISTRICT. Irena Obuchowska. Roczniki Panstwowego Zakladu Hig., 15: 323-8(1964). (In Polish)

Studies on radiostrontium levels in soil and plants were performed in the vicinity of Warsaw during 1962. Eighteen samples of soil (sandy soil) from 12 localities and 6 samples of white clover were analyzed. Radioactive strontium levels in soil varied from 1.4 to 18.5 mC/km^2 and in clover from 0.40 to 1.83 pC/g dry matter. These values are comparable to respective values from the literature. Radiocontamination with strontium was not alarming. (auth)

33779 RADIOAKTIVNAYA ZAGRYAZNENNOST' MOREI I OKEANOV. (Radioactive Contamination of Seas and Oceans). N. I. Baranov and L. M. Khutrov, eds. Moscow, Publishing House "Science," 1964. 224p.

Twenty-five articles are presented on radioactive contamination of seas and oceans by waste disposal fallout, and natural radioactivity. The results are given of measurements taken in the Indian and Pacific Oceans and the Black Sea during 1959–1960. Radiobiological effects on marine organisms are discussed. Methods for water sampling at various depths and radioactivity measurement are described. (R.V.J.)

Site Survey and Selection

33780 (NP-14145) ON-SITE RESISTIVITY AND SELF-POTENTIAL MEASUREMENTS. Final Report. (Allied Research Associates, Inc., Concord, Mass. and Massachusetts Inst. of Tech., Cambridge). Oct. 15, 1963. Contract AF49(638)-1101. 117p.

The success of geoelectric techniques in prospecting has led to experiments in their use for on-site inspection. The heat and pressure of an underground event drives interstitial water outward, producing a radial distribution of streaming potentials. These potentials give rise to circulating currents where the potential gradient shell intersects rock of varying conductivity. These currents manifest themselves in a radial potential pattern at the surface. Measurements at the sites of a number of events show that peak potential departures from ambient are in the range of 10 to 40 mv. The radius of detectable potential change is of the order of the depth of the event. The potential distribution builds up to its maximum value in a day or two, then decays with a characteristic time of weeks. This measurable decay may be used to distinguish nuclear sites from similar natural potential distributions. Field survey of potential patterns is complicated by large amplitude small-scale variability of surface potential, much of which may stem from plant activity. Electrode contact potentials, telluric currents, and man-made currents add further inaccuracies. Resistivity measurements showed a definite change in pattern from before an underground event to afterward. However, the resistivity pattern measured after the event showed of itself little indication of the location of the event. (auth)

Techniques and Equipment

Refer also to abstracts 33897 and 34251.

33781 AN ATTEMPT TO DETERMINE THE AGE OF ENCLOSING ROCKS OF THE MONCHEGORSK NICKEL-BEARING PLUTON WITH THE AID OF THE K–Ar AND Rb–Sr METHODS. E. K. Gerling, E. S. Varshavskaya, and I. M. Gorokhov (Lab. of Geology, Leningrad). Geokhimiya, No. 6, 500-4(June 1964). (In Russian)

The age of enclosing gneisses of the Monchegorsk pluton was determined with the Rb–Sr isochronous method on 6 whole rock samples. The value of 2700 ± 900 million years was obtained. The K–Ar age of biotites from these gneisses is indicative of the loss of argon in biotites in a later period. (auth)

33782 APPLICATION OF GAMMA-GAMMA LOGGING FOR DISCOVERING DEPOSITS OF TIN AND POLYMETALS IN THE SOUTH LITTORAL. A. N. Makarov. Vestn. Leningr. Univ., No. 6, Ser. Geol. i Geogr., No. 1, 148-51 (1964). (In Russian)

Methods of gamma-gamma logging, which were successfully applied in discovering ore bodies on the South Littoral, are described. (P.C.H.)

33783 INVESTIGATIONS OF PETROLEUM ORIGIN AND EVOLUTION MECHANISMS BY CARBON ISOTOPE STUDIES. S. R. Silverman (California Research Corp., La Habra). p.92-102 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

A review of published carbon isotope data of modern and ancient natural carbonaceous materials reveals consistently low $^{13}C/^{12}C$ ratios for materials of biologic origin as opposed to high ratios for carbonate minerals deposited in the oceans. Petroleum definitely falls into the biologic or organic isotopic range. This observation is compatible with other lines of evidence for its organic origin. $^{13}C/^{12}C$ ratios of petroleums are even lower than those of the organisms from which they were supposedly derived, but similar to the ratios of the lipid fractions of the organisms. This suggests that petroleum is derived from lipids, which are the most stable constituents of organisms. The isotopic composition of petroleum gas hydrocarbons and of narrow distillation fractions of the liquid petroleum phase suggests that the low molecular-weight hydrocarbon components of the gas and gasoline fractions are formed by decomposition of more complex compounds during the post-depositional history of petroleum. These transformation processes are also responsible for formation of some of the most complex petroleum components, such as the asphaltenes. (auth)

33784 PALEOTEMPERATURE ANALYSIS OF FOSSIL SHELLS OF MARINE MOLLUSKS (FOOD REFUSE) FROM THE ARENE CANDIDE CAVE, ITALY, AND THE HAUA FTEAH CAVE, CYRENAICA. C. Emiliani, L. Cardini, T. Mayeda, C. B. M. McBurney, and E. Tongiorgi (Univ. of Miami, Fla.; Università, Rome; Univ. of Chicago; Cambridge Univ., Eng.; and Università, Pisa, Italy). p.133-56 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The Arene Candide Cave (Italian Rivera) and the Haua Fteah Cave (Cyrenaica) contain sediments dating from more than 40,000 and 100,000 yrs ago, respectively. $^{18}O/^{16}O$ analysis of Trochus and Patella shells (food refuse) from different layers of the two caves have yielded a picture of climatic change which closely parallels that furnished by the fossil fauna and flora, and by the lithology of the sediments. The lowest deposits of the Haua Fteah Cave gave temperatures characteristic of the last interglacial age (Riss/Würm), while the overlying sediments, as well as the earliest sediments excavated in the Arene Candide Cave, gave glacial temperatures. A rapid temperature rise appears to have begun about 10,000 yrs ago and to have culminated in a marked post-glacial maximum extending from 6500 to 4500 yrs ago. A 2°C temperature decrease occurred between 4800 and 4000 yrs ago, followed by a 1°C rise which brought temperatures to their modern values. The temperature maximum correlates, by ^{14}C measurements, with the main portion of the Atlantic zone, and the subsequent minor minimum with the beginning of the Subboreal zone. (auth)

33785 OXYGEN ISOTOPE GEOTHERMOMETRY. James R. O'Neil and Robert N. Clayton (Univ. of Chicago). p.157-68 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The equilibrium oxygen isotope fractionations between calcite, quartz, and magnetite were experimentally determined. Each mineral was equilibrated with an aqueous solution in sealed gold or platinum tubes using conventional hydrothermal apparatus. Rocks containing coexisting

calcite, quartz, and magnetite yield two "isotopic temperatures" which are not concordant, yet the quartz-magnetite temperatures from these and other rocks are geologically reasonable. In general, quartz-calcite temperatures are too low and the reasons for this are not fuliy understood. (auth)

33786 OXYGEN ISOTOPE STUDIES ON THE ORIGIN OF DOLOMITES. Samuel Epstein, Donald L. Graf, and Egon T. Degens (California Inst. of Tech., Pasadena). p.169-80 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

Oxygen isotope measurements were made on co-existing dolomite and calcite pairs both from recent sedimentary deposits and from high temperature laboratory syntheses. In the limited number of synthetic carbonate samples thus far available, it appears that there is an oxygen isotope fractionation between dolomite and calcite, similar to that found in naturally occurring hydrothermal calcite-dolomite pairs. There is a lack of such fractionation between dolomite and calcite in young sedimentary deposits. It is therefore concluded that dolomite is a secondary product resulting from addition of magnesium to existing crystalline $CaCO_3$, which takes place without an isotopic change in the oxygen of the precursor $CaCO_3$. It is also shown that the $^{18}O/^{16}O$ ratio of dolomite is less susceptible to diagenetic re-equilibration with surrounding fluids than is that of calcite. (auth)

33787 COMPARISON OF OXYGEN ISOTOPE ANALYSES OF TEKTITES, SOILS, AND IMPACTITE GLASSES. Hugh P. Taylor, Jr., and Samuel Epstein (California Inst. of Tech., Pasadena). p.181-99 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

New oxygen isotope analyses of tektites from various localities were made, including two philippinites from Isabela, Philippine Islands, one of which contains small Ni–Fe spherules (Chao and others [1961]); a billitonite; a Muong Nong-type tektite, as well as a normal type, from Phang Daeng, Thailand; a Georgia tektite, and seven bediasites. The total range in δ-values for 24 tektites from widely separated occurrences is 8.9 to 10.8 per mil, relative to mean ocean water. Eight isotopic analyses of bediasites exhibit a good correlation with index of refraction, density, and SiO_2 content. The higher the $^{18}O/^{16}O$ ratio the lower is the SiO_2 content. The other analyzed tektites do not show this correlation. Thirteen randomly selected soils of various types (11 from the U.S.A.) have δ-values ranging from 10.0 to 15.9 per mil, and a series of samples from a soil profile in Georgia show a progressive increase of 5 per mil from the fresh granite up to the clay-rich B zone; sandy A zone material is 3 per mil lower in $^{18}O/^{16}O$ than the immediately underlying B zone. Two soil samples were selected for fusion experiments; it was found that melting increased the $^{18}O/^{16}O$ ratios of soils by about 1 per mil. Inasmuch as it would require a 3.5–4.0 per mil lowering of $^{18}O/^{16}O$ in soils to bring them into the tektite range, they appear to be unlikely parent materials for tektites. Four samples of impactite glass (Ries-2 samples, Wabar, and Henbury) give δ-values of 7.9, 9.0, 12.7, and 14.4. Dense, clean glass from the Ries Kessel, the sample which most closely resembles tektite glass in appearance, gave the smallest δ-value. The oxygen isotope data suggest that tektites are either fused terrestrial granitic rocks (with changed chemical composition), or they are extraterrestrial. (auth)

33788 THE WATER AND DEUTERIUM CONTENT OF PHENOCRYSTS FROM RHYOLITIC LAVAS. Irving Friedman (Geological Survey, Denver), Robert L. Smith, Betsy Levin, and Arthur Moore. p.200-4 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The water, deuterium, and fluorine contents of biotite and hornblende phenocrysts separated from extrusive rhyolitic lavas were determined. The minerals of high water contents are depleted in the heavier water HDO, compared to phenocrysts having a lower water content. A high water content biotite when heated in air lost H_2O by oxidation of the iron and escape of H_2. The remaining water was enriched in HDO. The spread of H_2O and relative deuterium concentration in the hydrous minerals is explained by changes in the oxidation state of the iron that occurs during cooling of the lava. (auth)

33789 GEOPHYSICAL IMPLICATIONS OF RADIOCARBON DATE DISCREPANCIES. Lowell Wood and W. F. Libby (Univ. of California, Los Angeles). p.205-10 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The accuracy of radiocarbon dates is directly dependent on the constancy of the geophysical factors controlling the rate of production and mixing. These relations are formulated and explored analytically and a specific example calculated on a high speed computer. (auth)

33790 A GEOCHRONOLOGICAL AND SEDIMENTARY PROFILE ACROSS THE NORTH ATLANTIC OCEAN. Edward D. Goldberg, Minoru Koide, John J. Griffin, and M. N. A. Peterson (Scripps Institution of Oceanography, La Jolla, Calif.). p.211-27 "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

Rates of sedimentation by the ionium/thorium method and mineral analyses have been made on a series of deep-sea cores collected between Martinique and Gibraltar by the 1962 Scripps Institution of Oceanography Expedition "Zephyrus." Lowest rates (on a calcium carbonate free basis) were found in the valleys on the mid-Atlantic Ridge where values of less than 1 mm/10^3 yrs were obtained, while in the open ocean region to the east and west of the Ridge, the rates were of the order of mm/10^3 yrs. There is evidence for at least three major changes in rates of sedimentation in Ridge valley cores within the last 300,000 yrs. The first two breaks occur at about 90,000 and 130,000 yrs respectively. The first break apparently corresponds to the one reported by Ericson and co-workers at 11,000 yrs. No explanation is offered for this discrepancy. Mineral analyses on both the gross sample and size separates indicate concentration gradients going from the continental coasts toward the Ridge. For example, quartz decreased and montmorillonite increased going from east to west along the sampling profile. Such distributional patterns allow the sources of these solid phases to be ascertained. Only a small portion of the sedimentary components of the Ridge sediments seemed to be derived from the Ridge itself. On the basis of the mineral distributions, it is proposed that the major part of the sediments in the Ridge valleys, other than carbonates, is of eolian origin. (auth)

33791 LEAD OF VOLCANIC ORIGIN. F. G. Houtermans (Universität, Bern), A. Eberhardt, and G. Ferrara. p.233-43 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The isotopic composition and specific activity of lead contained in recent fumarole sublimates from Mount Vesuvius, the island of Volcano, and the Valley of 10,000 Smokes, Alaska, are discussed in view of the hypothesis that leads of volcanic origin show J-type anomalies. The high specific activity of ^{210}Pb indicates that these leads

have been in close contact with radium or uranium, perhaps a short time before their crystallization. A possible connection between the specific activity of cotunnites and the volcanic activity of Mount Vesuvius is discussed. A decrease in specific activity seems to be connected with volcanic eruptions. At present, the specific activity decreases again. (auth)

33792 CHARACTERISTICS OF LEAD ISOTOPE EVOLUTION ON A CONTINENTAL SCALE IN THE EARTH. Clair Patterson (California Inst. of Tech., Pasadena). p.244-68 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

Recent investigations of lead isotopes in oceanic sediments, beach and river sands, and oceanic volcanics are reviewed from one comprehensive point of view: relatively large amounts of uranium and small amounts of lead have been continuously transported from the interior of the earth to an outer protocontinental layer throughout geologic time; continental segments were formed at different times from this layer, but such activity was largely confined to the interval 3500 m.yrs ago to 2500 m.yrs ago; uranium is enriched in the surface rocks of the continents by magmatic activity, but such rocks are well-mixed with uranium depleted material throughout a depth of a few tens of km during orogeny, so that lead isotope effects resulting from uranium enrichment can only be seen during aging in the quiet period following orogeny; the uranium-poor source layers of continental basalts, on the other hand, are not well-mixed with the overlying uranium-rich layers because leads in young continental basalts are relatively non-radiogenic, showing the effects of aging in relatively isolated uranium poor chemical systems; oceanic basalts are moderately radiogenic and originate from moderately uranium-rich materials (the protocontinents). (auth)

33793 REDISTRIBUTION OF STRONTIUM AND RUBIDIUM ISOTOPES DURING METAMORPHISM, WORLD BEATER COMPLEX, PANAMINT RANGE, CALIFORNIA. M. A. Lanphere (California Inst. of Tech., Pasadena), G. J. F. Wasserburg, A. L. Albee, and G. R. Tilton. p.269-312 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

An earlier Precambrian gneiss dome in the Panamint Range of California and its mantle of later Precambrian and Paleozoic rocks have been metamorphosed in late Mesozoic time. Uranium-lead analyses of zircons indicate the primary age of the older gneiss to be about 1800 million yrs and the age of a younger cross-cutting granite to be about 1300 to 1400 million yrs. Potassium-argon ages on biotite give ages ranging from 103–130 million yrs. Rubidium-strontium isotopic studies of all the constituent minerals and their associated total rocks yielded biotite-total rock isochrons indicating ages ranging from 64 to 156 million yrs. All of the total rock ages deviate considerably from the apparent primary age indicated by the zircon ages. The intercept values of $^{87}Sr/^{86}Sr$ for the isochrons from the various rocks range from 0.85 to 1.08. Nearly complete isotopic homogenization of strontium has occurred locally during this metamorphic episode for all mineral systems except apatite and muscovite. The "total rock systems" were open in some cases, including samples as large as 85 kg. There is obvious mineralogic and field evidence for metamorphism in the mantling sediments but no evidence for gross recrystallization and mobilization in either the mantling rocks or the underlying gneiss and granite. Even though original textures and structures, both sedimentary and igneous are preserved, the observed homogenization of strontium indicates that extensive migration of strontium occurred and affords a sensitive test of metamorphism. Conditions causing the redistribution of strontium in the gneiss did not lower the lead-uranium ratios of the zircons by more than 30%. A basic dike of later Precambrian age was found to contain radiogenic strontium due to partial equilibration with the neighboring gneiss. This rock gives an apparent age of 31.4×10^9 yrs and presents evidence for strontium transport over a distance of 5 m. (auth)

Thorium and Uranium Minerals

33794 (NP-14176) TABLA PARA LA DETERMINACIÓN DE MINERALES RADIACTIVOS POR MEDIO DE RAYOS X. Informe No. 105. (Tables for the Determination of the Radioactivity of Minerals by X Rays). Report No. 105. E. Linares, R. O. Toubes, C. O. Latorre, M. K. de Brodtkorb, and E. Chaar (Argentina. Comisión Naciónal de Energia Atómica, Buenos Aires). 1964. 55p.

Tables are presented for approximately 140 minerals in order of decreasing d values. Intensity measurements for the d spacings are included. A bibliography of 25 references is included. (B.O.G.)

33795 HARD BITUMEN IN URANIUM-BEARING VEINS. B. V. Brodin and Yu. M. Dymkov. At. Energ. (USSR), 16: 432-7(May 1964). (In Russian)

The appearance of calcite-anthraxolite metasomatosis in existing carbonate-uraninite-containing veins is described. Relations of later deposits of calcites and anthraxolites with minerals of carbonate–uraninite combinations and the peculiarities of their diffusion in veins of ore are considered. (tr-auth)

33796 ISOTOPIC EVIDENCE ON THE ORIGIN OF THE COLORADO PLATEAU URANIUM ORES. Donald S. Miller (Rensselaer Polytechnic Inst., Troy, N. Y.) and J. Laurence Kulp. Bull. Geol. Soc. Am., 74: 609-30(May 1963).

Uranium-lead isotopic ages of the Colorado Plateau primary-uranium ores were measured by the isotope-dilution method on discrete mineral phases. The ages obtained from Jurassic rocks range from 65 to 175 m.y. (million years) and from Triassic rocks 22-220 m.y.; it is unlikely that uranium was introduced into the Plateau during a single period. The $^{238}U-^{206}Pb$ ages from one mine vary up to a factor of three. The $^{238}U-^{206}Pb$ and $^{235}U-^{207}Pb$ ages on the same sample commonly differ by more than the experimental error. Two hypotheses proposed to explain these problems are based on subsequent loss of radiogenic lead and incorporation of old radiogenic lead at the time of mineral formation. The new data present serious questions for the original radiogenic-lead hypothesis. The isotopic ages obtained from the three ratios $^{238}U/^{206}Pb$, $^{235}U/^{207}Pb$, and $^{207}Pb/^{206}Pb$ on Colorado Plateau samples are usually not concordant, and no direct relationship to the absolute geologic age can be obtained. Under the lead-loss hypothesis, however, the $^{235}U-^{207}Pb$ ages are considered the most reliable, providing at all times a minimum age. The theory of origin of these deposits that is most probable and also consistent with the isotopic data involves deposition of uranium by ground water in H_2S-rich locations. This generally occurs shortly after sedimentation but may also occur later, if circulatory conditions are favorable. (auth)

33797 ON THE GEOCHEMISTRY OF THORIUM IN NEPHELINE SYENITES OF THE KOLA PENINSULA. A. I.

Polyakov and G. A. Kot (Vernadskii Inst. of Geochemistry, Moscow). Geokhimiya, No. 6, 505-17(June 1964). (In Russian)

With the aid of the ion-exchange–photometric method thorium was determined in a series of mesozoic nepheline syenites of the Kola peninsula (Lovozero, Khibina, Kontozero, and Soustov massif) and in rocks of the Ilimausak massif (Greenland). A high thorium content (35 g/t) is characteristic of rocks of the Lovozero massif; high thorium contents were also found in rocks of the Ilimausak massif. Nepheline syenites of other massifs, being characterized by a lower coefficient of agpaitity, contain thorium in lesser amounts. A correlation between the thorium content and the oxidation degree of iron in lujavrites was noted. The behavior of thorium in contact pocesses was considered. (auth)

HEALTH AND SAFETY

Refer also to abstract 33519.

33798 (AE-147) REPORT ON THE PERSONNEL DOSIMETRY AT AB ATOMENERGI DURING 1963. K-A Edvardsson and S Hagsgård (Aktiebolaget Atomenergi, Stockholm). July 1964. 17p. (UDC-614-89)

The results of the personnel dosimetry at AB Atomenergi during 1963 are presented. No doses exceeding the recommendations of ICRP were reported. The sum of the reported external total body doses during the year is for AB Atomenergi 64.2 mrem which, distributed over the whole company personnel, corresponds to about 40 mrem per year and person or about 1% of the maximum permissible dose. Thirty seven thousand eight hundred gamma films and 6700 neutron films were evaluated. The total number of urine analyses is 3603 and of whole body measurements 211. (auth)

33799 (CONF-620-2) IMPORTANCE OF NUCLEAR MATERIALS MANAGEMENT IN THE ASSURANCE OF NUCLEAR SAFETY. Vincent Vespe (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). [nd]. Contract [AT (29-1)-1106]. 7p.

From Institute of Nuclear Materials Management 5th Annual Meeting, Pittsburgh, May 1964.

Facilities carrying out operations with substantial quantities of fissile material have the real safety hazard of inadvertently assembling enough material to form a critical mass with a resultant criticality accident. Such an accident may result in multiple deaths or injuries to plant personnel. Fissile materials operations, especially if plutonium is included, require the control and measurement of all effluents from the plants to assure that undue hazard to the surrounding communities is not created. An important part of the safety resides in knowledge of the location and amounts of radioactive material. This means good records and good measurement are an absolute necessity. The interest of both materials management and safety are served in a production control and accounting system which can continuously supply this information. (auth)

33800 (EUR-1821.f) UNITE MOBILE D'INTERVENTION ET DE DECONTAMINATION DES SOLIDES. (Portable Plant for the Decontamination of Buildings and Equipment). G. Fontaine, R. Laurent, and A. Malvicini (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 27p.

A description is given of a portable unit for decontamination of buildings and equipment, in use at the Euratom Center of Ispra, or at any point in the Community. A description is also given of the special equipment and supplies designed to handle all types of emergencies. (auth)

33801 (HW-80204) ESTIMATES OF GROUND-LEVEL AIR EXPOSURES RESULTING FROM PROTRACTED EMISSIONS FROM 70-METER STACKS AT HANFORD. James J. Fuquay, Charles L. Simpson, and W. Ted Hinds (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 2, 1964. Contract AT(45-1)-1350. 29p.

Data from theoretical and experimental studies of atmospheric diffusion were used for estimating the consequences of discharging radioactive and chemically toxic materials from 70-m stacks at Hanford on environmental exposure at ground level. Hanford diffusion data obtained in field experiments were used to determine the parameters of Taylor's equation for lateral growth. It was found that the lateral growth of a plume could be expressed solely in terms of wind observations taken near the source. This result led to the derivation of air exposure values from the bivariate normal model accounting for the wind variability characteristic to the Hanford site. The air exposures expected from prolonged releases of 2, 4, 8, and 24-hr from a Hanford 70-m stack during conditions of atmospheric stability were calculated using wind data from the Hanford tower. Results indicated that radiation exposure estimates for the emission periods were generally much lower than those previously derived for Hanford. (C.H.)

33802 (HW-80216) HANFORD MOBILE WHOLE-BODY COUNTER. F. Swanberg, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 31, 1963. Contract AT(45-1)-1350. 17p.

The semitrailer-housed whole-body counter laboratory is described. The shadow shield concept is used. (R.E.U.)

33803 (LA-3094) SOURCE MEASUREMENT: DETERMINING THE RELEASE FROM A POINT SOURCE BY REMOTELY LOCATED SAMPLERS. Richard W. Henderson (Los Alamos Scientific Lab., N. Mex.). Oct. 1963. Contract W-7405-eng-36. 20p.

The effluent from some chemical and nuclear processes may be offensive or constitute a health hazard. Proper control requires a knowledge of the source characteristics. Often, measurement of the source cannot be accomplished by a direct technique. By employing a distant, circular sampling array, Sutton's equation can be modified for the calculation of the release from any such inaccessible point source. A second method for approximating the strength of radioactive clouds using gamma intensity rate detectors is given. (auth)

33804 (LADC-6432) LARGE VOLUME OPERATIONAL ROOM INERTING. Keith Boyer (Los Alamos Scientific Lab., N. Mex.); Harry Otway, and R. C. Parker (Los Alamos Scientific Lab. Nuclear Rocket Development Station, Jackass Flats, Nev.). [nd]. Contract [W-7405-eng-36]. 12p. (CONF-554-2)

From Cryogenic Engineering Conference, Philadelphia, Aug. 1964.

The explosive and fire hazard involved in the handling of gaseous and liquid hydrogen can be eliminated by the use of room inerting techniques whereby the air in the structure is replaced with an inert nitrogen atmosphere. The type of facility design necessary, the operation of such a system, and the safety factors involved are discussed. Both theoretical and experimental results regarding quantities of inerting gas are presented. This system provides for continuing safe operation even in the presence of fairly massive hydrogen leaks. (auth)

33805 (NIRS-2(p.57-67)) ENVIRONMENTAL STUDIES. (Japan. National Inst. of Radiological Sciences, Tokyo).

Experiments on the ^{137}Cs concentration in human urine and estimation of ^{137}Cs body burden due to world-wide fallout; gamma-emitting nuclides with intermediate half lives in rain water; the increase of ^{90}Sr and ^{137}Cs in Japanese leafy vegetables due to the Russian nuclear

tests; the comparative behavior of Sr and Ca in fish gill absorption in environmental water with different amounts of Ca; the uptake of ^{182}Ta by fish; Sr–Ca discrimination in rats feeding on rice, milk, and commercial diets; the attachment of radioactive iodine gas on aerosol particles; and the radioactive substances in sewage are reported. (H.M.G.)

33806 (NYO-10715) FUNDAMENTAL INVESTIGATIONS OF THE BEHAVIOR OF AEROSOLS. Final Report. S. K. Friedlander (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). July 1964. Contract AT(30-1)-2165. 7p.

Progress is reported in fundamental investigations of the behavior of atmospheric aerosols. A simplified method was developed for studying heterogeneous particle dispersions. Data are included from studies of condensation by mixing in a vapor jet, measurements of the size distribution of the atmospheric aerosol, and particle impaction on bodies of simple geometric shape at high Mach numbers and in a free molecular flow. (C.H.)

33807 (RISÖ-78) PERSONNEL DOSIMETRY PRACTICE AT RISÖ. Renee McCarthy and V. Mejdahl (Denmark. Atomenergikomissionene. Forsøgsinstitut, Risø). Feb. 1964. 47p.

A survey of the personnel dosimetry practice at the Danish AEC Research Establishment Risö is presented. Dosimeter types, calibration facilities, and procedures and dark-room equipment are described; and dose-evaluation methods are outlined. The performance of the Kodak PM2 beta/gamma film and Kodak type B neutron film were studied. Results of investigations on energy dependence, latent-image stability, and the effect of heat and humidity are presented. (auth)

33808 (AEC-tr-6459) STUDY OF THE TRAPPING OF IODINE BY ACTIVE CHARCOALS. F. Billard, G. Chevalier, and J. Pradel (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Translated by W. S. Durant (Savannah River Lab., Aiken, S. C.), from report CEA-2237. 1962. 19p.

The efficiency of an active charcoal toward iodine-131 has been studied during a series of experiments. The influence of the iodine concentration of the air current, the rate of flow of air across the charcoal, and the charcoal thickness has been determined. The results obtained lead to the conclusion that the iodine, after passage across a so-called "absolute" filter, is present in two different forms, and that the action of the active charcoals is different for the two forms. These results make it possible, however, to calculate industrial filters with a good degree of approximation. (auth)

33809 (HW-tr-78) FINAL REPORT ON THE ACCIDENT WHICH OCCURRED DURING A PURIFICATION OF PLUTONIUM ON ION-EXCHANGE RESINS JUNE 26, 1962, IN THE RADIOCHEMICAL BUILDING OF CENFAR (CEN-FONTENAY-AUX-ROSES). Translated by E. R. Appleby (General Electric Co., Hanford Atomic Products Operation, Richland, Wash.), from a publication of the Plutonium Department, Services of Plutonium Chemistry. July 26, 1963. 11p.

Studies were conducted to determine the causes of the accident. The conditions of the accident are described briefly; they include reused Dowex 1-X-4 anionic resin, high acidity, and extremely long time of contact. Studies of the stability of the resin in HNO_3 indicate that the resin is quite stable for HNO_3 concentrations of 7 to 10 N. Recommendations for users of ion exchange resins are presented which include limits on the acidity of the solution, short contact times, and the use of coarse resin particles. (D.L.C.)

33810 THE SPATIAL DISTRIBUTION OF THE DOSE OF SCATTERED RADIATION FROM A MONODIRECTIONAL GAMMA-RAY SOURCE IN AN INFINITE MEDIUM IN THE VICINITY OF THE SOURCE. V. I. Kukhtevich, E. S. Matusevich, and L. A. Trykov. At. Energ. (USSR), 16: 453-5(May 1964). (In Russian)

The air dose, near the region of Compton scattering, was measured for gamma energies from 0.05 to 10 Mev. An ionization chamber with air-equivalent walls was used as a detector. The isotopes ^{198}Au, ^{137}Cs, ^{60}Co, and ^{24}Na were used as gamma sources. The ratio of dose scattered in air to unscattered dose in the absence of the medium was measured for angles from 0 to 180°, effective energies from 0.412 to 1.86 Mev, and various source-to-detector distances. Experimental points are compared with calculated curves. (M.J.T.)

33811 EFFECTS OF NUCLEAR EXPLOSIONS ON WATERSHEDS. T. F. Craft (Georgia Inst. of Tech., Atlanta). J. Am. Water Works Assoc., 56: 846-52(July 1964).

Studies were made on changes and the forces that bring them about on watersheds in the event of a nuclear attack or accident. Of primary importance in determining the blast damage sustained by the watershed are the nature and density of the vegetative cover, the topography of the region, the size of the weapon, the height of the burst, and the distance from ground zero. The degrees of damage are also discussed. (P.C.H.)

33812 DECONTAMINATION OF THE SKIN. M. H. Faes. J. Belge Radiol., 47: 178-87(1964). (In French)

There is no 100% efficient decontamination method available for all possible skin contaminations. Many unknowns still subsist such as percutaneous absorption, tolerance levels, and precise dosage methods for the contaminants not to speak of protective agents, decontaminating products, and their application techniques. Any skin decontamination begins usually with water and soap washing which gives good results in many cases. But residual contamination has to be removed by more drastic methods which have still to be investigated. There is a need for precise information about these methods since more and more radioisotopes are to be used in the future by less and less skilled personnel. A few experiments were started that gave some positive results. (auth)

33813 UNUSUAL CANCER MORTALITY AMONG A GROUP OF UNDERGROUND METAL MINERS. Joseph K. Wagoner, Robert W. Miller, Frank E. Lundin, Jr., Joseph F. Fraumeni, Jr., and Marian E. Haij (National Cancer Inst., Bethesda, Md.). New Engl. J. Med., 269: 284-9(Aug. 8, 1963).

The mortality among a group of metal miners in the United States who were occupationally exposed to relatively low levels of radioactivity was studied, and the results were compared with those found in U miners. The miners (1759) had completed a minimum of 15 yr underground mining experience. In the metal miners, compared with control men, all forms of respiratory disease greatly exceeded expectation, the excess being seven-fold for tuberculosis; three-fold for neoplasms, and two-fold for influenza and pneumonia. Diseases of the heart, possibly secondary to pulmonary disease, were also markedly increased, each difference being significant at the 1% level. There was also an excess of deaths in the category all

other causes, a circumstance largely attributable to pneumoconiosis, and there were more cancers than expected involving all systems other than the digestive and respiratory systems. There was no obvious explanation for the mortality experience in this group of metal miners; however, the presence of a carcinogen admixed in the air of the mines appears likely. Mines in the present study in 1958 had atmospheric concentrations of Rn in the range of 10 to 80 $\mu\mu$C/l. The concentrations of the associated daughter products in the mines varied from 10 to 20% of recommended working levels. When the mortality patterns of the metal and U miners were compared, for total deaths there was a significant excess among metal miners. No significant increase in cancer was observed in the U group, except for the respiratory tract. (TCO)

33814 CIVIL DEFENSE. THE CITIZEN'S CHOICE. Barry Commoner. Nucl. Inform., 6· No. 7, 1-17(June-July 1964).

Civil defense is discussed in its role as the defensive aspect of nuclear war. Basic facts concerned with nuclear weapon types and stockpile magnitude, chemical and biological weapons, delivery vehicles, type of attack, and immediate consequences of attack are presented. The ability of society to recover from a nuclear war is considered in three parts: population, industry, and agriculture. (H.M.G.)

33815 PROVISION FOR RADIATION SAFETY IN FLIGHTS OF THE SOVIET COSMONAUTS IN THE VOSTOK SHIPS. Yu. M. Volynkin, V. V. Parin, V. V. Antipov, V. A. Guda, N. N. Dobrov, M. D. Nikitin, and P. P. Saksonov. Radiobiologiya, 4: 344-8(1964). (In Russian)

The system for radiation protection in Vostok ships provided for the prediction of radiation conditions in space, measurement of total dose and dose rate in the capsule, and use under emergency conditions of pharmacochemical agents. The average dose rates in the flights were: Vostok-1, 7.2; Vostok-2, 8.4; Vostok-3, -4, -5, and -6, 10 ± 2 mrad/day. Radiological studies carried out in these flights agreed with physical measurements. A slight damaging effect of flight factors on hereditary structures of some organisms (wheat seeds, lysogenic bacteria, Tradescantia microspores, etc.) was observed. There was no evidence of any cosmic radiation damage to the health of the cosmonauts from the clinical observations and special laboratory studies. The results permit a positive evaluation of the radiation protection system for human flights in Vostok-type capsules. (TTT)

33816 FIELD OF ACTION OF PUBLIC HEALTH IN THE DOMAIN OF RADIOPROTECTION. P. Pellerin. Rev. Hyg. Med. Sociale, 10: 661-70(1962). (In French)

The different domains which represent the field of activity of Public Health in radioprotection are natural radiation, medical radiation, and other causes of irradiation such as radioluminescent paints and fallout. The functions of Public Health in each of these domains are indicated. Cooperative efforts of the agency with other national and international agencies are briefly summarized. (J.S.R.)

33817 RADIATION ACCIDENTS AND EMERGENCIES. L. H. Lanzl and J. H. Pingel (Argonne National Lab., Ill.). Science, 143: 1352(1964). (ACRH-21(p.45-8))

A symposium on radiation accidents and emergencies in medicine, research, and industry was held in Chicago, Dec. 19 and 20, 1963. A brief summary is presented of the papers presented. While emphasis was placed on local emergencies and small accidents with ionizing radiation, a few papers also dealt with major catastrophes, short of a wartime holocaust. All pertinent aspects of a pure emergency situation were discussed, including accident dosimetry, handling of spills, medical responsibility, mass survey problems, control of post-accident exposures, psychological and legal considerations, and public relations. (C.H.)

33818 CERIUM-144 AND CESIUM-137 MEASUREMENTS IN THE 1963 UNITED STATES WHEAT CROP AND MILLING PRODUCTS. Doris C. Sutton and Kenneth R. Dwyer (Atomic Energy Commission, New York). Science, 145: 486-7(July 31, 1964).

The distribution of an abundant short-lived (285 days) nuclide, cerium-144, and a long-lived (30.5 years) nuclide, cesium-137 was measured in wheat samples and milling products by means of radiochemical methods. The patent flour fraction contained approximately 10 and 15 percent of the measured cerium and cesium. (auth)

33819 TOTAL COUNTING AND SPECTROSCOPY IN THE ASSESSMENT OF ALPHA RADIOACTIVITY IN HUMAN TISSUES. W. V. Mayneord and C. R. Hill (Royal Cancer Hospital, Belmont, Surrey, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/2, 23p. (CONF-448-4)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

A seven-year program of alpha-activity measurements is briefly reviewed. The program, based initially on a sensitive and simple counting technique using thin zinc cadmium sulfide screens, now employs in addition techniques of alpha spectroscopy developed for work with very large area low activity sources. These techniques are capable of measuring specific activities down to 10^{-13} Curie/g and can in certain cases provide energy resolution of the order of 40 kev together with independent identification based on half life. Two alpha spectrometers are described which were used on a wide variety of human and environmental materials. Particular attention was given to the study of ^{210}Po, now known to be present in a variety of foods and human tissues. Techniques are also described for the study of ^{239}Pu in the atmosphere, and examples are given of the results of measurements of low-level air contamination. Techniques for the measurement of ^{239}Pu in normal human tissues are described and some results given. Consideration is given to the contribution of ^{210}Po to the natural background radiation dose in human bone and reproductive organs. It is shown that this contribution may be a significant fraction of the total dose received. (auth)

33820 EXPOSURE FOLLOWING INGESTION OF WATER CONTAINING RADON-22. I. Ö. Andersson and I. Nilsson (Aktiebolaget Atomenergi, Studsvik, Sweden). Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/74, 12p. (CONF-448-29)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

There exist wells in Sweden that supply water for consumption which have ^{222}Ra concentrations above 100 nC/l. The problem of estimating the radiation dose to man following ingestion of radon-rich water was investigated. Two subjects were each given about one liter of radon-rich water and the external γ radiation was studied by repeated measurements in a whole-body counter. Chair geometry and an 8 × 4 in. NaI(Tl) scintilaation spectrometer were applied. The decay of the gamma activity was followed until the signal was indiscernible from background radiation. By analyzing the decay curve and particularly the decay

of the 0.6 Mev peak of RaC, it was possible to determine a biological half life (T_B) of radon in the body. With knowledge of T_B we could calculate the energy absorbed in the body at an intake of radon and radon daughters and thus determine the radiation dose to total body. A value of the radon concentration $(MPC)_w$ that corresponds to a dose rate of 0.1 rem/week to total body was obtained. Preliminary results are for T_B = 35 min and for $(MPC)_w = 6 \times 10^{-4}$ μC/cc. (auth)

33821 A CALCULATIONAL METHOD, BASED ON EXCRETA ACTIVITY, OF DETERMINING ABSORBED DOSE FROM PROLONGED INTAKE OF Ra^{226} USING EXCRETION. V. M. Malykhin and V. P. Shamov. Vienna, International Atomic Energy Agency, 1964, Preprint SM-52/83, 20p. (CONF-448-32) (In Russian)

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg, May 1964.

A calculational method of determining body burden due to ^{226}Ra is presented. The activity of the excreta and the time of contact with radium constitute the starting data. The results can thus be used by a wide circle of radiobiologists not possessing special apparatus for determining Ra burden by exhaled radon or by measurement of the γ activity of its daughter products with the aid of large counters. Values of the effective excretion constant λ_{eff} for contact times t_1 = 2, 4, 6, 8, and 10 years and elapsed times after contact $t_2 - t_1$ = 2, 4, 6, 8, and 10 years are given. These values are obtained on the basis of an exponential excretion model and uniform uptake of Ra by the body over the period of contact. Using the values of λ_{eff} it is possible to determine the Ra content of the skeleton from the excreta activity. On the basis of these same model assumptions, an analytical expression is obtained for the dose to the skeleton for the whole time since start of contact. For the sake of convenience the results are presented as a graph of the dose coefficient K_D, which is equal to a dose of 1 pC Ra/day in the excreta. The magnitude of the dose is determined by simply multiplying the activity of the excreta by the calculated dose coefficient K_D. (auth)

33822 TRANSPORTING SPENT FUEL. Neil Ritchey (Knapp Mills, Inc., Wilmington, Del.). 13p. (CONF-504-13)

From American Power Conference 26th Annual Meeting, Chicago, Apr. 1964.

The evolution of spent-fuel shipping casks and associated services is discussed. (M.C.G.)

33823 THE MODES OF FORMATION AND THE PROPERTIES OF AEROSOL PARTICLES. K. Stewart. 20p. (CONF-561-2)

From Symposium on Inhaled Radioactive Particles and Gases, Richland, Wash., May 1964.

In a brief survey of particle formation and properties, some of the complexities of the problems that arise are discussed. By simple experiments it is possible to demonstrate the fraction of material likely to be released under some selected conditions as particles in the respirable size range. The assessment of the hazard from the respirable fraction can be given in broad terms from the size distribution and chemical nature of the toxic material. (P.C.H.)

INSTRUMENTATION

General

Refer also to abstract 34752.

33824 (AD-428788) SUPERCONDUCTIVE EFFECTS IN THIN FILMS. Interim Engineering Report No. 7, July 15–October 15, 1963. S[idney] Shapiro and E. J. McNiff, Jr. (Little (Arthur D.) Inc., Cambridge, Mass.). Contract AF33(657)-7915. 19p.

The mixing of two microwave signals, which has been accomplished unambiguously in experiments employing the non-linear I-V characteristic of superconducting tunneling samples, is described. Although a doubly-resonant microwave cavity was used in the earliest experiments, difficulties with cavity Q-values led to the adoption of a scheme in which the sample was situated roughly a quarter guide wavelength from the end of a shorted waveguide. The latter scheme, where the sample sees predominantly r-f E-field, was very effective for both mixing and video detection. The 30-Mc mixed signal was amplified and displayed on an oscilloscope. The noise and rather low sensitivity of the post-mixer amplification and display arrangement precluded obtaining sufficient data for detailed analysis. (auth)

33825 (AD-435095) PERFORMANCE OF RADIATION-RESISTANT MAGNETIC AMPLIFIER CONTROLS UNDER FAST NEUTRON AND GAMMA IRRADIATION. Preliminary Report. R. Sherwin and J. Montner (Marquardt Corp., Van Nuys, Calif.). Aug. 30, 1961. 44p. (S-222)

The results of subjecting three amplifier designs and a magnetic voltage reference to nuclear radiation under constant temperature conditions are described. Essentially, all components comprising the amplifiers are unaffected by irradiation through a range of 10^{16} nvt, except for semiconductor diodes. The circuits were specially designed to tolerate gross degradation in diode reverse impedance characteristics. Under non-nuclear conditions at 70°F, a 200 volt diode normally leaks less than 0.5-microamp of current in the reverse direction. These circuits were designed with diodes shunted by resistors so as to operate with precision to a point where radiation damage could cause diode reverse leakage to increase by a factor of five hundred. It was expected that with selected diodes (G.E. ZJ 225) this leakage tolerance condition (factor of 500 increase in reverse current) would occur after 10^{15} nvt. Results indicate that amplifiers did retain their precision performance until diode leakage did actually degrade by a factor of five hundred. The best amplifier showed no significant change in gain, linearity, frequency response, or tolerance to power supply variations until after the integrated flux level exceeded 2×10^{15} nvt. An unanticipated immediate deterioration under irradiation in approximately 60 percent of the ZJ 225 diodes caused some of the circuits to degrade at flux levels in the vicinity of 10^{13} to 10^{14} nvt. This immediate deterioration in some of the G.E. ZJ 225 diodes is considered irregular since considerable data have been published by other investigators showing no serious deterioration in the diode characteristics until flux levels exceeded 10^{15} nvt. Since the particular diodes used in this program were a special order, fabricated at a different time by G.E. from their preceding successful diodes, it is possible that differences in manufacturing process will explain the unexpected performance of certain of the diodes. In addition to the amplifiers, their components such as selected magnetic cores, capacitors, resistors, and diodes were irradiated in quantity to obtain statistical data. The results of the tests confirm the radiation resistance characteristics of all amplifier components except the ZJ 225 diodes in which 60 percent of the ZJ 225's exhibited the unexpected and sudden deterioration. For those circuits in which the ZJ 225's performed as predicted, the amplifiers performed per specification. Data were acquired showing a positive correlation between ZJ 225 deterioration and radiation rate (unexpected). When the radiation rate was momentarily diminished the malfunctioning ZJ 225's demonstrated an immediate recovery. Performance characteristics are given for a 4800 cps amplifier, 400 cps amplifier, 400 cps ultra-low-level signal amplifier, and magnetic voltage reference. (auth)

33826 (DP-897) A VERSATILE ELECTRONIC TRIP DEVICE. William J. Woodward (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). June 1964. Contract AT(07-2)-1. 7p.

A simple alarm trip unit was designed to operate from the recorder output voltage from a micro-microammeter without affecting recorders connected to the same terminals. The unit has a constant-gain amplifier for millivolt signals, direct connections for higher level signals, a meter with a manually set trip contact, and fail-safe relay circuitry to operate associated reactor scram circuits. (auth)

33827 (EUR-1823.d) MESSUNGEN ZUR FULL-STANDANZEIGE, ZUR BENETZUNG UND ZUM BLASEN-NACHWEIS BEI FLUSSIGEM Na IN EINEM BEHALTER AUS NICHTROSTENDEM STAHL. (Level Indication Measurements, Wetting, and Bubble Indication of Liquid Sodium in a Stainless Steel Container). K.-H. Spiller and D. Perschke (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 40p.

With a pool-boiling device manufactured of stainless steel, tests are made with Na concerning the registration of charge levels, wetting, and bubbles. The method is based on changers of the electrical resistance. The level indication by an absolute method (calibration in ohms) is a bad one. A relative method is useful. Wetting does not happen suddenly. A better wetting begins at very different temperatures. With the tests, complete wetting was obtained at 240 to 320°C. Boiling bubbles are indicated well; bubbles of inert gas are not detected. (auth)

33828 (NASA-CR-54059) DEVELOPMENT OF ELECTRICAL SWITCHGEAR FOR SPACE NUCLEAR ELECTRICAL SYSTEMS. Quarterly Progress Report No. 3, January 16, 1964–April 16, 1964. R. N. Edwards (General Electric Co. Missile and Space Div., Cincinnati). Contract NSA-3-2546. 23p. (N64-24054)

Equipment is described for performance testing and evaluation of switchgear for use in space environments. The components actually under consideration include a-c and d-c circuit breakers and engine contactors. The proposed operation environment includes pressures down to 10^{-15} torr, temperatures up to 1000°F, and radiation doses up to 10^{15} fast neutrons/cm^2 and 10^9 gamma rads over the proposed lifetime of 20 khr. (T.F.H.)

33829 (NOLTR-63-134) THE USE OF A KNOCK-OFF TUBE AS A QUICK PRESSURE-RELEASE MECHANISM (thesis). Robert L. Davis (Naval Ordnance Lab., White

Oak, Silver Spring, Md.). May 4, 1964. 56p. (AD-602198)

The reactor-vessel containment work currently being conducted is dependent largely upon ability to monitor the internal pressure-time histories of dynamically loaded model reactor vessels. These histories are determined through the use of tourmaline piezoelectric gages mounted on the internal walls of the vessel. The need for a calibration system that will accurately relate the output of the piezoelectric gages to known pressures is manifest. Inherent to a piezoelectric gage calibration system is a quick pressure-release mechanism that can release the pressure of a confined fluid very rapidly. The rapid release will produce transient loadings on the gages of the same order of magnitude as those obtained in the model reactor vessels. An analysis is presented of the use of a knock-off tube as a quick pressure-release mechanism. An equation relating the pressure-release time to the initial conditions of the calibration system has been derived and verified, within certain limitations, for select choices of the initial conditions that are compatible with requirements of the NOL Reactor-Vessel Containment Program (NOL-285). A method for selecting a safe, workable knock-off tube that will give a required pressure-release time is presented, followed by a brief discussion of a universal knock-off tube for use in this program. (auth)

33830 (NYO-10556) APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 4, August 1 to September 30, 1962. (Aeroprojects, Inc., West Chester, Penna.). Oct. 1962. Contract AT (30-1)-2910. 13p.

The design of the acoustic components for a foam-water interface detector for the Borax V Reactor is finalized and the proposed construction details are given. The design of level indicators for molten salts or liquid metals is reported. These models are expected to eliminate problems associated with liquid drainage and interelement reflections. (auth)

33831 (NYO-10558) APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 8, December 1, 1962 to January 31, 1963. (Aeroprojects, Inc., West Chester, Penna.). Feb. 1963. Contract AT(30-1)-2910. 10p.

The final assembly and testing of the foam-water interface detector were completed. The results of the tests were satisfactory. (auth)

33832 (NYO-10560) APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 10, April 1, 1963 to May 31, 1963. (Aeroprojects, Inc., West Chester, Penna.). June 1963. Contract AT (30-1)-2910. 19p.

The initial assembly and testing of the foam-water interface detector at Idaho Falls have been scheduled. An ultrasonic void-fraction probe has been tested and calibrated in boiling water. Measurements were found to be very sensitive to the conditions of the boiling water during test. An acoustic thermometer was constructed, using steel sensing elements. Phase-shift responses useful for the measurement of temperatures, within the range of the system, were measured. Work was initiated on a higher temperature instrument using molybdenum in the sensing elements. A continuously indicating, ultrasonic liquid-level gage was tested in water, and showed an approximately linear response to liquid-level changes. (auth)

33833 (ORNL-TM-883) HIGH-TEMPERATURE HIGH-VACUUM THERMOCOUPLE DRIFT TESTS. J. W. Hendricks and D. L. McElroy (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 30p. (CONF-512-9; CONF-638-4)

From American Society for Testing and Materials 67th Annual Meeting, Chicago, June 1964 and National Physical Laboratory Conference on Thermal Conductivity, Teddington, Eng., July 1964.

A facility for prolonged testing of the thermal electromotive force (emf) stability of thermocouples at high temperatures and high vacuums is described. Using a $Pt_{90}Rh_{10}$/Pt referee thermocouple and an optical pyrometer referee, tests in the range 1200 to 1450°C for times up to 1000 hr at pressures between 10^{-6} and 10^{-8} torr have shown a lack of thermal emf drift for platinum–rhodium- and tungsten–rhenium-base thermoelements. Commercial thermocouples of the type $Pt_{90}Rh_{10}/Pt$, $Pt_{94}Rh_6/Pt_{70}Rh_{30}$, $W/W_{74}Re_{26}$, and $W_{95}Re_5/W_{74}Re_{26}$ were shown to be stable within ±10°C for the test conditions. Wire size and alloy content did not affect the stability in these tests. Posttest examinations revealed only minor changes in surface appearance for the stable thermocouples. One test at 1450°C did show that drift of thermal emf could be expected in $Pt_{94}Rh_6/Pt_{70}Rh_{30}$ thermocouples if the hot junction is joined to niobium and exposed to a severe temperature gradient. This is apparently caused by compositional inhomogeneities due to diffusion of niobium. Severe thermal emf changes were observed at 1200°C in tantalum- and niobium-sheathed, MgO-insulated $Pt_{90}Rh_{10}/Pt$ thermocouples. This was apparently caused by a reaction between the thermoelements and MgO. (auth)

33834 (RT/EL(63)-15) UN NUOVO DISPOSITIVO SPERIMENTALE PER L'ESECUZIONE DI MISURE SULL'EFFETTO MÖSSBAUER. (A New Mössbauer Effect Analyzer). E. Lo Prato (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Oct. 1963. 27p.

The analyzer is composed of an electromechanical function generator that feeds a position servo, which drives the source carriage at preset speed. The value of the speed, accurately adjustable from 0.01 to 1 cm/sec, is constant to 1% in a fixed part of the stroke. An electronic programmer produces start-stop signals for two electronic counters connected to a counting chain; counting times are proportional to the length of the stroke with a precision better than 3%. Circuit diagrams and performance curves are shown. (auth)

33835 (RT-EL(64)-3) DISCRIMINATORE RAPIDO A DIODO TUNNEL CON ESTESO INTERVALLO DINAMICO. (Tunnel Diode Fast Discriminator with Wide Dynamic Interval). B. Righini (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Elettronica, Rome). Jan. 1964. 7p.

A fast voltage amplitude discriminator based on a tunnel diode is described. The circuit can analyze pulses whose amplitude ranges between 0.4 and 6.5 v and gives a fast standard output pulse 10-v high, 28-nsec wide whose rise time is lower than 2 nsec. The circuit is stable for input pulse frequencies between 10 cps and 10 Mc/s, and for room temperature variations between 0 and 45°C. (auth)

33836 (RT/EL(64)-5) IL TRANSISTOR PLANAR COME ELEMENTO LOGARITMICO. (The Planar Transistor as Logarithmic Element). M. Conti (Italy. Comi-

tato Nazionale per l'Energia Nucleare, Rome). Feb. 1964. 11p.

The use of planar transistors in logarithmic period amplifiers, multipliers, etc., is discussed. An accuracy of 0.2% is obtainable for 5-decade input. The circuitry and method of measuring are described. (R.E.U.)

33837 (RT/EL(64-8) SISTEMA DI REGISTRAZIONE DEI DATI PER ESPERIENZE DI FISICA NUCLEARE. (Data Recording System for Nuclear Physics Experiments). S. Bevilacqua, A. Brunetti, and E. de Agostino (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Elettronica, Rome). Mar. 1964. 13p.

An automatic data recording system for nuclear experiments is described. The system is capable of receiving and recording data from four channels: decimal, binary, alphanumerical serial information coded according to eight channels standard IBM-8 system, and four decimal digits form. Paper tape records are provided by commercial punchers. (auth)

33838 (RTD-TDR-63-4287(Vol.I)) A STUDY OF NUCLEAR RADIATION EFFECTS ON TELEMETRY. VOLUME I. (LTV Vought Aeronautics. Div. of Ling-Temco-Vought, Inc., Dallas). Feb. 1964. Contract AF33 (657)-11646. 331p. (AD-433087)

The primary objectives were to (1) define representative nuclear radiation environments in which telemetry circuitry may be required to operate, (2) establish the capability of off-the-shelf telemetry modules to operate properly in these environments, and (3) evolve certain criteria and "working tools" for the design of nuclear radiation tolerant telemetry. The general approach used in accomplishing these objectives was (1) to provide a brief discussion of the effects of nuclear radiation on materials and components, (2) to discuss potential nuclear radiation environmental combinations that might affect the design of a telemetry system, (3) to establish a Representative Telemetry System Model (RTSM) which includes the pertinent building blocks which might be used in any specific system, (4) to compile, correlate, and present in a tabular format the applicable radiation effects information required to perform the detailed nuclear radiation effects analysis, and (5) to discuss certain criteria for the effective design of nuclear radiation tolerant telemetry modules. The information is presented in a manner that should be of most use to the non-nuclear oriented designer of telemetry electronics. References are listed for additional information. (auth)

33839 (RTD-TDR-63-4287(Vol.II)) A STUDY OF NUCLEAR RADIATION EFFECTS ON TELEMETRY. VOLUME II. NUCLEAR RADIATION EFFECTS DESIGN ALLOWABLES. (LTV Vought Aeronautics. Div. of Ling-Temco-Vought, Inc., Dallas). Feb. 1964. Contract AF 33(657)-11646. 300p. (AD-433088)

Approximately 1500 nuclear radiation effects (Design Allowables) on electronic materials and parts were compiled to provide a useful working tool for designing radiation-tolerant telemetry systems. The radiation effects Design Allowable is a nuclear radiation environmental exposure under which the associated material or part is expected to exhibit certain specified characteristic changes. The information presented does not include all available data, but is felt to be representative of the current nuclear radiation effects state-of-technology. This data should serve as an aid in performing nuclear radiation effects analyses of currently available telemetry systems and provide useful inputs for hardening such systems for use in a nuclear radiation environment. (auth)

33840 (TGGM-642) STUDY AND DEVELOPMENT OF SPECIFICATIONS FOR PROTOTYPE TRANSMITTERS AND RECEIVERS FOR FALLOUT SHELTER COMMUNICATIONS SYSTEMS. Final Report. (Gautney & Jones, Consulting Engineers, Washington, D. C.). May 1964. Contract OCD-PS-64-8. 63p. (AD-600065)

Described is a study approach to the problem of developing specifications for equipment for a radio backup to a landline fallout shelter communications system. Consideration is given those aspects of shelter programs which contribute requirements for electrical performance of the equipments. Discussions are included concerning frequency availability and usage, cost analysis, state of the art, recommendations, and full specifications for three types of radio equipment are given. The conclusions reached during this study are that a radio backup to a landline communications system is technically feasible and a substantial savings in costs relative to that of presently available commercial radio equipment can be realized. (auth)

33841 (TID-20833) A STUDY OF CERTAIN ASPECTS OF THE FAILURE OF KLYSTRON WINDOWS. Bimonthly Report No. 2. (Stanford Univ., Calif.). [196?]. Contract AT(04-3)-363. 28p.

Many windows fail due to internal damage of the window and the pits and eruptions at the surface are merely symptoms of the internal damage. The mechanisms likely to be responsible for such damage are explored. The most likely mechanism appears to be gas discharge in pores within the ceramic. The power loss due to such gas discharges is computed. A model for window failure is described. It comprises: gas discharges within the pores of the ceramic when the field is high enough, a change in apparent dielectric constant due to the discharges which permits excitation of the ghost mode, high-power dissipation near the field maximum of the ghost mode with consequent damage to the window in the form of melted channels in the body of the alumina, and discharges external to the window when and if the damage reaches the surface so that gas evolution can feed the external discharge. The observed x rays arise from high-energy electrons in the external discharge. (N.W.R.)

33842 (TID-20834) A STUDY OF CERTAIN ASPECTS OF THE FAILURE OF KLYSTRON WINDOWS. Bimonthly Report No. 3. (Stanford Univ., Calif.). [nd]. Contract AT(04-3)-363. 9p.

Many windows fail due to internal damage of the window and the pits and eruptions at the surface are merely symptoms of the internal damage. The mechanisms likely to be responsible for such damage are explored. The most likely mechanism appears to be gas discharge in pores within the ceramic. Window life is somehow dependent on the external environment. A tentative model is described pertaining to window failures; this model takes into account the role of environment and the multipactoring effects. (N.W.R.)

33843 (AEC-tr-6399(p.1-9)) UNIFIED AUTOMATIC CONTROL DEVICE FOR USING A MODULATED RADIOACTIVE RADIATION. N. N. Shumilovskiĭ, V. A. Yanushkovskiĭ, Yu. V. Gushchin, V. N. Pozdnikov, V. A. Kiryukhin, and R. A. Lein'. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 3-10(1962).

The variety of instruments developed for radiometric measurement and control, has led to the need for unified automatic control systems built out of standard blocks. A first variant of such a unified system has been produced. The system comprises a transducer and a measuring device, and the various forms of transducers and measuring devices (blocks) are described together with their applications. (D.L.C.)

33844 (AEC-tr-6399(p.10-20)) STATISTICAL CHARACTERISTICS OF INSTRUMENTS WITH A FEEDBACK LOOP ENCLOSING THE RADIATION SOURCE. B. I. Verkhovskii and M. I. Podgoretskii. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 11-19(1962).

Radiometric control instruments usually are constructed in accordance with the principle of follow-up or automatic-compensation systems. In these instruments, the output signal is also used as a feedback signal to the radiation striking the detector. Errors due to instrument instability are reduced, but there are unavoidable statistical fluctuations of the output signal. A mathematical treatment of these fluctuations is presented which shows that feedback through the radiation source does not lead to an increase in the variance of the measurements. (D.L.C.)

33845 (AEC-tr-6399(p.21-9)) HYSTERESIS OF THYRATRON RELAYS. Mo. L. Gol'din and A. G. Vasil'ev. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 20-6(1962).

Hysteresis is an important factor in the reliability of thyratron relays in the control of slowly varying quantities. Such hysteresis can be obtained by suitable choice of the circuit elements. An equation is derived for the return coefficient of thyratron relays, and it is shown that the coefficient is a function of both the parameters of the circuit and the operating mode of the thyratron. Experimental results are compared with calculations for a very simple thyratron relay. (D.L.C.)

33846 (AEC-tr-6399(p.30-42)) GAMMA RELAYS FOR SMALL DROPS IN RADIATION INTENSITY. L. M. Gerber, Mo. L. Gol'din, and V. D. Rutgaĭzer. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 27-36(1962).

A radiometric instrument was designed for the detection of burnout places in pipes used in evaporative cooling of blast furnaces. The instrument comprises a control panel with a thyratron relay, a power supply, control devices, six transducers (source + detector), and six shielded cables. The instrument uses gamma radiation to determine the presence or absence of water at six places in the pipes. The operation of the relay and other components is described. (D.L.C.)

33847 (AEC-tr-6399(p.124-37)) PROCEDURE FOR CALCULATING THE RADIOACTIVE SOURCE OF A DENSITY METER WITH IONIZATION CHAMBERS. A. K. Val'ter, M. L. Gol'din, and V. I. Slavin. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 102-12(1962).

A gamma source-ionization chamber setup is used for the measurement of pulp density. The design of such a setup involves the problem of calculating the proportionality coefficient between the saturation current in the chamber and the activity of the gamma source. A solution to this problem is presented. (D.L.C.)

33848 (AEC-tr-6399(p.138-52)) RADIOACTIVE DENSITY METER PR-1014. L. I. Faĭnberg, I. I. Kotik, and I. Ya. Serebrennikov. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Takhn. i Priborostr., 1961, 2: 113-24(1962).

The density meter type PR-1014 was developed for measuring density in the range 0.75 to 3.5 g/cc, of pulps and solutions which are transported in pipes. The meter uses either ^{60}Co or ^{135}Cs, and its principle, radiation source calculations, construction, and performance are described in detail. (D.L.C.)

33849 (AEC-tr-6399(p.153-62)) FOLLOW-UP RADIOMETRIC LEVEL METER WITH STATIONARY RADIATION SOURCE. V. N. Afanas'ev. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 125-33(1962).

The advantages of a follow-up radiometric level meter, with stationary source and moving detector, are discussed relative to positional-type meters. The stability of the follow-up meter is analyzed. The URMS-2 level meter, which is of this type, is described. (D.L.C.)

33850 (AEC-tr-6399(p.163-72)) SCINTILLATION COUNTERS WITH LIGHT DUCTS IN INSTRUMENTS FOR TECHNOLOGICAL CONTROL. E. Ya. Ovcharenko. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Iztopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 134-40(1962).

Several applications of light ducts for coupling scintillators with photomultipliers in radiometric instruments are described. In one instrument, modulated radiation is applied alternately to a scintillator after passing through the controlled object and to a compensation scintillator which is coupled with the photomultiplier by means of a glass light duct which curves around the controlled object. Liquid light ducts are next considered, and data are presented on the effects of length of various liquids on the photomultiplier current. Such light ducts find application in a follow-up level meter using a scintillation counter. Other radiometric applications of liquid light ducts are considered briefly. (D.L.C.)

33851 (AEC-tr-6399(p.177-85)) DOSING SYSTEM FOR A UNIFIED AUTOMATIC CONTROL DEVICE, USING MODULATED RADIOACTIVE RADIATION. N. N. Shumilovskii and Yu. V. Gushchin. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 145-52(1962).

A dosing system is described which uses scaler circuits with sequential pulse count by magnetic elements with rectangular hysteresis loop. Schematic diagrams are given for the pulse-shaping block, scaler decade, and coincidence circuit. The operation of the dosing system for continuous and one-shot dosing is described. (D.L.C.)

33852 (AEC-tr-6399(p.196-201)) USE OF CONTROL-MEASURING INSTRUMENTS WITH NUCLEAR RADIATION

IN THE BUILDING-MATERIALS INDUSTRY. D. M. Kheĭker, L. A. Sukhova, and E. Ya. Lube. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 161-5(1962).

The following applications of radiometric instruments are described: level indication in bunkers and jaw crushers in asbestos enrichment factories, density measurement in asbestos-cement, and weight determination in roofing paper, parchment, and cardboard. (D.L.C.)

33853 (AEC-tr-6399(p.207-20)) ESTIMATE OF SOME POSSIBILITIES OF INCREASING THE EFFICIENCY OF TRANSMISSION OF RADIOACTIVE-EMISSION PARAMETERS. A. A. Bragin and V. V. Mikhaĭlovskiĭ. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren, Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 171-81 (1962).

In well logging with remote measurement of radioactivity, it frequently is necessary to reduce the measurement time and bandwidth. The following devices for carrying out the reductions are investigated: equalizer with nonperiodic and periodic reading mode, scaler with periodic reading mode, and circuit with amplitude conversion. (D.L.C.)

33854 (AEC-tr-6399(p.221-6)) GAMMA EXPOSURE METER. D. Rasulov, A. A. Korzun, B. S. Mazitov, and A. T. Lebedev. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 182-6(1962).

In γ defectoscopy, a large number of parameters determine the quality of the picture. An exposure meter was developed which chooses the best nominal integral dose for a given film and ray hardness, independently of the object thickness, duration, etc. The principle and operation of the exposure meter are described. (D.L.C.)

33855 NOISE CONTRIBUTION TO THE LINE BROADENING IN PARAMAGNETIC RESONANCE. F. De Martini (Istituto di Fisica del Politecnico, Milan). Energia Nucl. (Milan), 11: 308-14(June 1964).

A theory of noise in oscillating systems is applied to the marginal oscillator in order to evaluate the noise contribution to the line broadening in paramagnetic resonance detection. Two other instrumental line broadening effects are considered that are related to the rate of passage of the modulation magnetic field over the resonance line. The corresponding line widths Δf_τ (relaxation width) and Δf_T (frequency indetermination width) are compared with the noise width $\overline{\Delta f}$. Also, a method of autocorrelation is described that was used to give the experimental check of the theory. (auth)

33856 INSTRUMENTATION AND AUTOMATION IN A NUCLEAR FUEL REPROCESSING PLANT. Alain Mongon. Energie Nucl., 6: 150-8(May 1964). (In French)

The automation of a nuclear fuel reprocessing plant as the one constructed in Mol (Belgium) by the Société Eurochemic, where highly radioactive products are handled, is one of the objectives of the Instrumentation specialists. The aim of the Société Eurochemic and the setting up of its plant are briefly described. After having recalled to mind the reasons for the particular solutions that were adopted for the plant, measurements and apparatus, such as conventional measurements and measurements of a nuclear nature are discussed. Plans for carrying out studies on automation in the second cycle extraction stage are described. (P.C.H.)

33857 A TUNNEL DIODE TIME MARK GENERATOR. H. W. Lefevre (Univ. of Oregon, Eugene). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 426-30 (June 1964).

A recycling time mark generator was developed in which the only active element is a shunt connected tunnel diode. The diode is mounted at the junction of a 50Ω stripline T. Two legs of the T are joined with a length of coaxial cable; the third leg proceeds 2.5 cms to a five port mis-match. The mis-match provides five input-output ports, and its distance from the diode determines the pulse width. Pulse width is about 0.8 ns and recycling periods as short as 3 ns and as long as 160 ns were used. With a selected diode, up to two hundred pulses can be simultaneously recirculated in a 160 ns RG-8 transmission line indefinitely. Short term instability of circulation period as measured by beating the radiated signal with a quartz crystal is less than 0.05 ps. Bias coefficient of circulation period is 8 ps per mv at 90 mv with a TD-103 diode, and the tuning range which can be obtained by varying bias is 150 ps. The temperature coefficient of circulation period is 1.5 ps per °C. These measurements were made with a circulation period of 100 ns. (auth)

33858 APPARATUS FOR MEASUREMENT OF VISCOSITIES OF LIQUIDS AT TEMPERATURES TO 500°C AND UNDER PRESSURES TO 200 kg/cm^2. R. Bessouat and S. Elberg (CEN, Grenoble, France). J. Phys. (Paris), 25: Suppl. to No. 3, 23A-30A(Mar. 1964). (In French)

An apparatus built for studies of organic reactor coolants is described, which uses Lawaczek's falling cylinder viscometer principle. A magnetic device measures the velocity of the falling cylinder. The accuracy of viscosity determinations is about ±0.7% at room temperature and ±1.2% at 500°C. The results of some measurements on diphenyl, terphenyls OMP and OM2, and coolants of petroleum origin are presented. (auth)

33859 EXAMPLES OF USE OF A MULTIPARAMETER RECORDER. Rene Ballini (CEN, Saclay, France). J. Phys. (Paris), 25: Suppl. to No. 3, 31A-7A(Mar. 1964). (In French)

Some results obtained by multiparametric recording are summarized, and some devices designed for angular distribution measurements are described. (auth)

33860 LIQUID SCINTILLATOR-METHODS FOR CALCULATION OF AVERAGE ENERGY REQUIRED TO PRODUCE ONE PHOTOELECTRON. D. L. Horrocks (Argonne National Lab., Ill.). Nucl. Instr. Methods, 27: 253-8(May 1964).

Two methods were used to obtain the average energy dissipated in a particular liquid scintillator system to produce one photoelectron at the photocathode of a multiplier phototube. One method involves the determination of the average pulse height of the pulse height distribution from the amplification of single electrons originating from the photocathode. This average single electron pulse height was compared to the pulse heights produced by the excitation of the liquid scintillator with alpha particles and electrons of known energy. The other method involves a subtraction of that part of the line width due to factors outside of the multiplication system of a multiplier phototube. The solution of a modified Gaussian equation gave the number of photoelectrons associated with any pulse height and line

width. Good agreement was obtained between the two methods. For excitation with electrons with energy above 300 kev, the average energy per photoelectron was essentially constant for each of two selected multiplier phototubes at 0.5 and 0.6 kev. For excitation with alpha particles the average energy per photoelectron, also dependent upon the multiplier phototube, varied from about 7 kev with 4.0 Mev alpha particles to about 5 kev with 7.0 Mev alpha particles. (auth)

33861 A TRANSISTORIZED FAST PULSE AMPLIFIER. J. J. Samueli, G. Espi, and A. Sarazin (Institut de Physique Nucléaire, Lyon). Onde Elec., 43: 1256-9(Dec. 1963). (In French)

A pulse amplifier which has a driving and load impedance of 50Ω with a nominal gain of 20 db is described. The mean rise time and maximum output amplitude are of the order of 2 nsec and 3 v, respectively. The amplifier handles negative pulses. (D.C.W.)

33862 DESIGN AND CONSTRUCTION OF A NEW COAXIAL ELECTRICAL DISCHARGE PIN. Richard J. Wasley, Joseph F. O'Brien, and Darwin R. Henley (Univ. of California, Livermore). Rev. Sci. Instr., 35: 466-8 (Apr. 1964). (UCRL-7455)

A new design for coaxial electrical discharge pins for recording rapid transient events (motion of shock disturbances) was developed. The method of construction involves vapor plating techniques for the deposition of the dielectric and outer conductor. The performance of these pins ("Sigma" pins) was measured at pressures from nearly 0 to 360 kbars. The response time (the time interval between 10 and 90% of the linear portion of the total amplitude of the signal received) of the pin is less than 0.005 μsec. (auth)

33863 IONIZATION METHOD OF MEASURING CONTACT POTENTIAL DIFFERENCES. K. W. Bewig (Naval Research Lab., Washington, D. C.). Rev. Sci. Instr., 35: 1160-2(Sept. 1964).

A modification of the ionization method of measuring the contact potential difference between two surfaces is described which permits remote separation between the source electrodes and the indicating meter. Elapsed time recording is easily accomplished. The errors resulting from large separation between the electrodes are analyzed. (auth)

33864 SPIN DECOUPLER FOR NMR. Joseph H. Noggle (Harvard Univ., Cambridge, Mass.). Rev. Sci. Instr., 35: 1166-9(Sept. 1964).

A homonuclear spin decoupler was developed which, in conjunction with a Varian HR60 nuclear magnetic resonance spectrometer system, may be used for frequency sweep single or double resonance or for field sweep double resonance. (auth)

33865 NEW TYPE OF FLUX METER FOR THE MEASUREMENT OF HIGH MAGNETIC FIELDS AT LOW TEMPERATURES. J. R. Houck and R. Bowers (Cornell Univ., Ithaca, N. Y.). Rev. Sci. Instr., 35: 1170-2(Sept. 1964).

A flux meter is described which is convenient for high field measurements at low temperatures. The device is based on a magnetoplasma resonance and produces an audio-frequency signal whose frequency is proportional to the magnetic field. The device has a linearity of better than 1% between 10 and 80 kG. (auth)

33866 SIGNAL ENHANCEMENT OF THE VARIAN A-60 NMR SPECTROMETER. Ralph E. Mayo and J. H. Goldstein (Emory Univ., Atlanta). Rev. Sci. Instr., 35: 1231-2(Sept. 1964).

A simple automatic technique for enhancing the sensitivity of NMR spectrometers is described. The technique involves the use of the A-60 integrator over a sequence of equally spaced spectral points. This procedure can be carried out automatically with a set of microswitches operated by a motor-driven cam arrangement. The switching circuit is illustrated. (C.E.S.)

33867 THE MASS SPECTROMETER AS AN EFFUSIOMETER. J. M. McCrea (United States Steel Corp., Monroeville, Penna). p.71-91 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

Molecular weights may be determined by use of a mass spectrometer as an effusiometer, but adequate precautions must be taken to evaluate the effects of adsorption and thermal decomposition. An extended form of Graham's Law of effusion which includes adsorption terms describes the behavior of the mass spectrometer system satisfactorily. In addition to molecular weight determination, effusion data are valuable for study of adsorption, chemical equilibrium in gases at low pressure and the origin of anomalous peaks in mass spectra. (auth)

33868 TWO MODIFICATIONS OF SCALERS FOR RATE STUDIES. T. S. Hodgson and B. E. Gordon (Shell Oil Co., Martinez, Calif.). 12p. (CONF-179-8)

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

Two simple modifications to nuclear scalers are described. One involves an automatic stepping switch which permits a single scaler to be actuated by up to four Geiger counters in sequence and to record the time to reach a preset count for each. The other is designed to pick a pulse off a conventional scaler when a preset count is reached and to use the pulse to actuate a recorder. (auth)

33869 NUCLEAR RADIATION TOLERANCE OF TIMM. J. Hannabach and D. D. Mickey (General Electric Co., Pittsfield, Mass.). 39p. (CONF-536-6)

From National Winter Convention on Military Electronics, Los Angeles, Feb. 1964.

The advantages and theoretical bases of the TIMM (Thermionic Integrated Micro-Modules) approach to radiation-resistant electronic equipment are summarized, and the steady-state and transient radiation tests performed on TIMM materials, components, and devices are reviewed. (D.C.W.)

33870 IMPROVEMENTS IN DEVICES FOR MEASURING SMALL MAGNETIC FIELDS, IN PARTICULAR THE EARTH MAGNETIC FIELD, BY NUCLEAR INDUCTION. Georges Bonnet, Jean-Louis Laffon, and Pierre Emile Servoz-Gavin (to Commissariat a l'Energie Atomique). British Patent 964,017. July 15, 1964. Priority date July 5, 1960, France.

A device is described for measuring small magnetic fields of less than 10 gauss by means of measurements of the free precession frequency of atomic nuclei in the field being measured. In the device, a paramagnetic substance with a saturable electronic resonance line is used to reduce the intensity of the polarizing field (Overhauser-Abragram effect), and also to reduce the duration of the application of this field on the order of milliseconds. (D.L.C.)

33871 IMPROVEMENTS IN OR RELATING TO METHODS OF AND FLOW METER FOR MEASURING THE RATE

OF FLOW OF LIQUID IN A CONDUIT. Salomon Elberg and Claude Favreau (to Commissariat à l'Energie Atomique). British Patent 964,735. July 22, 1964. Priority date Jan. 13, 1961, France.

A flowmeter device is designed which does not cause pressure drops and power losses in the liquid flow. The device comprises a transparent conduit, an electromagnetic valve for interrupting the liquid flow momentarily in order to form a free surface, and a photoelectric assembly near the conduit for measuring the time required for the free surface to pass between two reference points in the conduit. (D.L.C.)

33872 IMPROVEMENTS IN OR RELATING TO TEMPERATURE-INDICATING DEVICES. Peter Murden (to Pye Ltd.). British Patent 964,741. July 22, 1964. Filed Mar. 15, 1962.

A device for measuring the temperature of a hot chamber, such as in a reactor, is described which offers advantages over thermocouples. The device comprises a quartz crystal having a steep frequency temperature characteristic and being coupled in the circuit of an oscillator through a coaxial cable an odd multiple of a quarter wavelength long at the mean crystal frequency. The crystal is inserted in the hot chamber, with the oscillator outside, and a frequency meter is used to indicate the temperature. (D.L.C.)

33873 TRANSISTORIZED ANALOG-TO-DIGITAL CONVERTER. R. L. Chase (to U. S. Atomic Energy Commission). U. S. Patent 3,140,479. July 7, 1964.

A transistorized analog-to-digital converter using a height-to-time conversion technique is described. A capacitor is charged by a transistor to a voltage proportional to the input analog signal. At the moment the capacitor reaches its peak charge, the feeding transistor is automatically cut off to isolate the charging capacitor during its subsequent rundown. At the end of the latter period, the feeding transistor is automatically unblocked to receive the next signal. (AEC)

33874 DEVICE FOR MEASURING GAS PRESSURE BY MEANS OF ALPHA PARTICLES. Robert Nash Brown, David Balber, and Gregory Vladimir Rylsky (to General Precision Inc.). U. S. Patent 3,141,970. July 21, 1964. Filed May 15, 1961.

A device for accurate measurement of gas density (or pressure) by observation of the range of alpha particles from a source in the gas is described. From the relation of air density and altitude, precise determinations of altitude can be made. (D.C.W.)

33875 HIGH VACUUM SPUTTER-ION GETTERING APPARATUS. William A. Lloyd and Sherman L. Rutherford (to Varian Associates). U. S. Patent 3,141,986. July 21, 1964. Filed Sept. 18, 1961.

A sputter-ion device using nonuniform and/or curved magnetic fields and providing nonparallel gas discharge paths is described. The anodes and electrodes comprise an alternate series of flat plates, the anodes containing openings that define gas discharge paths. At least part of the anode openings are not perpendicular to the plane of the plate. An anode embodiment for use with a uniform rectilinear magnetic field is also described. (D.C.W.)

Radiation Detection

Refer also to abstracts 33478, 33659, 34274, and 34755.

33876 (BNL-8180) MULTIPLE NEUTRON SPECTROMETER CONTROL SYSTEM. R. J. Spinrad (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT (30-2)-Gen-16]. 10p. (CONF-593-3)

From Conference on the Automatic Acquisition and Reduction of Nuclear Data, Karlsruhe, Ger., July 1964.

A computer-controlled system of eight neutron spectrometers scheduled for operation by 1965 at the Brookhaven High Flux Beam Reactor is described. The spectrometers are completely controlled, on a time-shared basis, by a single stored-program digital computer, which will perform a certain amount of real-time data reduction. (R.E.U.)

33877 (DP-893) A WALK-THROUGH HAND AND SHOE MONITOR FOR BETA-GAMMA CONTAMINATION. Harold V. Hardison (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). June 1964. Contract AT (07-2)-1. 7p.

Design features are described of a monitor for the detection of gross β-γ contamination on the hands and feet of personnel as they leave a regulated area. The monitor produces audible and visual alarms if β-γ contamination is present. The shoe-monitoring system contains 32 G-M tubes mounted beneath an expanded metal platform. The hand-monitoring system contains 4 G-M tubes covered by expanded metal shields mounted in the horizontal section of each handrail. Circuit diagrams are included and engineering drawings are available. (C.H.)

33878 (HW-81774) INTEGRATOR FOR A PORTABLE NEUTRON DOSE RATE METER. C. A. Ratcliffe and E. M. Sheen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1964. Contract AT(45-1)-1350. 9p.

An integrator, meeting the instrument requirements, was developed and a prototype was fabricated and tested. The integrator requires only 25 mw of power from the portable survey instrument, and the life of the small register battery is in excess of 3.5×10^5 events, equivalent to 35 indicated rem. The integrator outside dimensions are $2 \times 3 \times 5$ in. The circuits were temperature tested and satisfactory operation was obtained from 0 to 150°F. The circuits are tolerant of normal component value variation and no component selection is necessary. In addition to the planned application with portable neutron survey instruments, the integrator could be adapted to count pulses from other sources in the range of 0 to 10^5 counts/min. (auth)

33879 (HW-SA-3585) IN-PILE DOSIMETRY TECHNIQUES AND STANDARDIZATION IN THE U. S. H. H. Yoshikawa (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 25, 1964. Contract AT (45-1)-1350. 8p. (CONF-621-1)

From IAEA Panel on In-Pile Dosimetry, Vienna, July 1964.

Methods of in-pile neutron and gamma dosimetry are reviewed, and initial progress in dosimetry standardization is discussed. (R.E.U.)

33880 (NDL-SP-6) GLASS MICRODOSIMETRY SYSTEM USED AT THE U. S. ARMY NUCLEAR DEFENSE LABORATORY. Edward E. Lissak and Robert J. Smith (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). May 1964. 34p.

The silver-activated phosphate-glass microdosimeter system employed at the U. S. Army Nuclear Defense Laboratory is explained. The advantages and disadvantages of the system, as well as the idiosyncracies of the microdosimeters themselves, are reported. It is concluded that

this system provides an efficient and reliable method of determining gamma dose in the range from 10 to 4×10^6 rads. (auth)

33881 (NP-14131) THE NEUTRON DIFFRACTOMETER AT VINČA. Milutin S. Zivadinovic (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). Nov. 1963. 9p.

A neutron diffractometer of the M.A.N.-type was installed at the RA reactor at Vinča. It is intended for the investigation of polycrystalline specimens and for single-crystal structure work. The neutron diffractometer is described in detail, as are its physical, operational, and functional characteristics. (auth)

33882 (NYO-3190-1) DEVELOPMENT OF A FIVE INCH HIGH SPEED PHOTOMULTIPLIER. Final Technical Report, June 10, 1963–June 9, 1964. F. A. Helvy (Radio Corp. of America. Industrial Tube and Semiconductor Div., Lancaster, Penna.). Contract AT(30-1)-3190. 52p.

The tube (type C70133) that was developed is a fourteen-stage, five-inch photomultiplier having the following characteristics: short pulse rise time; small transit time spread; uniform collection efficiency over a great fraction of the entrance window area; and low equivalent anode dark current input. (auth)

33883 (ORNL-TM-897) ENERGY RESPONSE OF THE ORNL CUTIE PIE CHAMBER TO PHOTON RADIATION. E. D. Gupton and D. M. Davis (Oak Ridge National Lab., Tenn.). June 18, 1964. Contract [W-7405-eng-26]. 7p.

The energy response of the ORNL Cutie Pie Chamber in the measurement of photon radiation dose rates, with respect to absorbed dose in air, was found for the energy range from 8 to 1200 effective kilovolts. Compared with the response to air equilibrium gamma rays from a ^{226}Ra standard source, the response of the Cutie Pie Chamber was within less than 2 per cent from 100 to 1200 kilovolts, 5 per cent from 20 to 1200 kilovolts, and 10 per cent from 8 to 1200 kilovolts. (auth)

33884 (RT/EL(64)-7) UNITÀ AUTOMATICA PER CONTEGGIO. (Automatic Counting Scaler). A. Carlucci, F. Fioroni, and A. Sandò (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Elettronica, Rome). Feb. 1964. 24p.

A fully transistorized automatic scaler performing preset or pretime counting and time measurements is described. Electrical or manual operative control is provided. The results appear on luminous indicators and a decimal output is provided for printing. The design criteria of some circuits are described. (auth)

33885 (AEC-tr-6399(p.173-6)) COUNT-TIME TELERADIOMETER SVT-1. V. N. Afanas'ev. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 141-4(1962).

The SVT-1 teleradiometer was designed for measuring radiation intensity, transmitting the data over a distance, registering them on a paper chart, and in some cases processing the position regulation signals. The meter can be used with continuous or discrete measurements, and comprises three blocks: transducer, converter, and registering instrument. (D.L.C.)

33886 (JPRS-25467(p.9-24)) COUNTERS AND DOSIMETERS FOR STUDYING SHIELDING AND THE PROTECTIVE PROPERTIES OF MATERIALS. V. N. Avaev (Avayev), G. A. Vasil'ev (Vasil'yev), Yu. A. Egorov (Yegorov), et al. Translated from p.260-70 of "Voprosy Fiziki Zashchity Reaktorov."

Scintillation counters, all-wave counters (BF_3-filled), fast-neutron dosimeters (plastic scintillators), and gamma scintillation dosimeters are disucssed. Their uses in shielding-materials evaluation are considered. (R.E.U.)

33887 (NASA-TT-F-126(p.102-37)) A STANDARD CUBICAL TELESCOPE. Ya. L. Blokh. (A translation)

A description of the counter telescope and some representative results for locations in the Soviet Union are presented. (R.E.U.)

33888 (NASA-TT-F-126(p.138-60)) AZIMUTHAL TELESCOPE FOR THE INVESTIGATION OF VARIATIONS OF COSMIC RAYS IN DEPENDENCE ON THE INCIDENT DIRECTION OF THE PRIMARY RADIATION. O. I. Inozemtseva and Yu. A. Kapitonov. (A translation)

The diurnal variations of cosmic-ray intensity were studied using counter telescopes with narrow solid angles. The counters are described. (R.E.U.)

33889 (NASA-TT-F-126(p.161-76)) REGISTRATION OF THE INTENSITY OF COSMIC RAYS WITH PLASTIC SCINTILLATORS. N. S. Kaminer. (A translation)

A "counter telescope," which uses plastic scintillators instead of Geiger-Mueller counters, is described. The performance of these organic scintillators for registering the hard (meson(μ)) component of cosmic radiation is discussed. (R.E.U.)

33890 (NASA-TT-F-126(p.177-9)) RADIOSONDE FOR MEASURING THE INTENSITY OF THE COSMIC RADIATION IN THE STRATOSPHERE. A. N. Charakhch'yan. (A translation)

The circuitry of a Russian cosmic-ray radiosonde for registration of the intensity of cosmic particles with the aid of a single counter or a telescope consisting of two Geiger counters is described. (R.E.U.)

33891 (ORNL-tr-216) HIGH-LEVEL DOSE EFFECTS IN RECENT SILVER-ACTIVATED METAPHOSPHATE GLASSES. K. Becker (Kernforschungsanlage, Jülich, Germany). Translated for Oak Ridge National Lab., Tenn. June 1, 1964. 27p.

Radiation-induced absorption changes in dosimeter glasses according to Yokota, which were exposed to γ doses greater than 10^3 r, are investigated with respect to the fluorimetric and absorption photometric measurement of γ doses between 10^3 and about 10^7 r. For the measurement in the range of about 10^3 to $5 \cdot 10^4$, a thermally rather stable absorption band at 315 mμ is particularly suitable, while wave lengths up to 550 mμ (minimum sensitivity) are applicable for higher doses, although their thermal stability is lower. The practical and theoretical aspects of the experiments are briefly discussed. (auth)

33892 DETERMINATION OF THE FREQUENCY OF VARIOUS TYPES OF EVENTS BY THE MAXIMUM LIKELIHOOD METHOD. Éva Gombosi and L. Jánossy (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung., 16: 361-5(1964).

The actual intensity of nuclear events and the statistical fluctuation of this value were determined by means of the maximum likelihood method from the number of events found in emulsion plates. At the same time investigations were made on scanning efficiency to determine whether, in order to reduce statistical errors, it is better to scan a small surface several times or a larger surface less often. (auth)

33893 PULSE AMPLITUDE ANALYSIS WITH PHOTOGRAPHY ON MOVING FILM. V. S. Pantuev and M. N. Khachaturyan. At. Energ. (USSR), 16: 444-6(May 1964). (In Russian)

A simple and reliable apparatus for recording rare particle-interaction events at high energy is described. The block diagram of the complete apparatus and the circuit diagram of the calibrator are given. The two-beam oscillograph OK-17M is used for the main part of the amplitude spectrometer. Film development speeds to 50 nsec/cm are possible. For an amplifier of the vertical deflection, the UR-4 or a specially constructed amplifier with an amplitude of ±200 v with symmetric output is used. On the moving film pulses of length 0.1 μsec are photographed from lead glass Cherenkov counters placed in a 3-Bev pion beam of the synchrophasotron. For one cycle of the accelerator, the film covers a length up to 20 cm. (M.J.T.)

33894 ON OPTIMAL SELECTION OF A α-EMITTER THICKNESS FOR LOW-LEVEL RADIOACTIVE PROBE SPECTROMETRY. L. S. Gorn and B. I. Khazanov. At. Energ. (USSR), 16: 447-9(May 1964). (In Russian)

For a given energy interval between spectral lines, there is an optimal thickness of the alpha emitter at which the measurement time for the required accuracy is a minimum. A method for calculating this optimal thickness is presented for specific cases. A formula for the energy distribution of alphas emitted in the general case is derived. Alpha spectra at different thicknesses and for two overlapping spectral lines are presented. (M.J.T.)

33895 SPECIFIC IONIZATION ALONG THE TRACK OF ^{235}U AND ^{244}Cm FISSION FRAGMENTS. F. Nasyrov. At. Energ. (USSR), 16: 449-51(May 1964). (In Russian)

A study was made of specific ionization in a mixture of Ar and 5% CH_4 by fission fragments from thermal-neutron fission of ^{235}U and spontaneous fission of ^{244}Cm. Measurements were performed using a telescope of pulse ionization chambers. Ion pairs formed per unit path length and energy loss per unit length for light and heavy fission fragments are given for both cases. The specific ionization energy loss dependence on velocity of fragments is presented for ^{235}U fission. The obtained value of W, energy per ion pair, coincides for both light and heavy groups of fragments. (M.J.T.)

33896 REMARKS ON THE EFFICIENCIES OF GEIGER, PROPORTIONAL, AND SCINTILLATION COUNTERS WITH APPLICATION TO THE ABSOLUTE INTENSITY OF CHARACTERISTIC X-RADIATION. V. Metchnik (Univ. of Adelaide, Australia). Australian J. Phys., 17: 200-4(June 1964).

The measurements of the absolute intensities of Cu Kα radiation, isolated by means of balanced nickel and iron filters, necessitated the determination of the quantum counting efficiency of three types of detectors: an end-window argon-filled Geiger counter, a two side-window, xenon-filled proportional counter, and a scintillation counter with NaITl crystal. It is shown that, provided the necessary corrections are made, results of absolute intensity measurements obtained with these three detectors show good agreement. (auth)

33897 CALIBRATION OF A NEUTRON MOISTURE METER IN LEDA CLAY. K. N. Burn (National Research Council, Ottawa). Can. Geotech. J., 1: 94-103(Mar. 1964). (NRC-7847)

A neutron moisture meter using a scintillation detector for slow neutrons was previously calibrated in materials carefully selected to avoid inaccuracies resulting from neutron absorption. Preliminary readings of moisture density in the field using this calibration, however, were not in agreement with values obtained by auger borings. Consequently the instrument was recalibrated, in the laboratory using samples of remolded Leda clay and in the field, by taking readings throughout a summer in the natural material. Details of moisture content and density control are described. The new calibration curve is parallel to the original one, but considerably displaced from it by what appears to be a neutron absorption effect. Chemical analyses of the clay and pore water failed to detect any elements whose capture cross-sections for neutrons are large. They did however indicate a high percentage of iron whose capture cross-section is a little larger than those for elements occurring naturally in mineral soils. Although further research is required for confirmation of this observation, results of preliminary experiments point primarily to the presence of iron in quantities large enough to explain the discrepancy between the two calibration curves. (auth)

33898 LINEAR LOW-NOISE PULSE AMPLIFIER FOR SEMICONDUCTING RADIATION DETECTORS. Ctirad Rumler and Karel Putz (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Prague). Cesk. Casopis Fys., 14: 94-9(1964). (In Czech)

A cascade amplifier for semiconductor detectors is described. Shaping is done by tanking the derivative and integrating RC circuits. The equivalent noise charge at an input capacity of 40 pf is 1.1×10^{-16} C. (D.C.W.)

33899 THE COUNTING OF PARTICLES ARISING FROM THE BOMBARDMENT OF A TARGET WITH A VARIABLE BEAM. Abdelmalek Guessous (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France). Compt. Rend., 258: 5640-2(June 8, 1964). (In French)

The mean number of events recorded by a counter with constant dead time was determined for particles emitted by a target bombarded by a beam of any intensity. The mathematical expectation of the number of events counted, for any intensity of the incident beam, by a single counter having a constant dead time was derived. (J.S.R.)

33900 NINTH SCINTILLATION AND SEMICONDUCTOR COUNTER SYMPOSIUM, WASHINGTON, D. C., FEBRUARY 26-28, 1964. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 1-458(June 1964). (CONF-182)

Scintillators, photomultipliers, image intensifiers, semiconductor radiation detectors, spark chambers, computer data handling, analysis of scintillation spectra, and electric circuits and systems are discussed. Separate abstracts are prepared for 41 of the 67 papers presented. The remaining papers were previously abstracted in NSA (17: 32458 and 18: 10421, 14222, 14224, 14225, 20279, 20326, 20327, 20343, 20344, 21158, 21699, 22326, 22695, 23865, 25739, 25779, 27610, 27805, 28080, 28199, 29674, 29797, 30068, 30069, and 31861). (C.E.S.)

For abstracts of individual papers see: 33221, 33636, 33637, 33638, 33857, 33901, 33902, 33903, 33904, 33905, 33906, 33907, 33908, 33909, 33910, 33911, 33912, 33913, 33914, 33915, 33916, 33917, 33918, 33919, 33920, 33921, 33922, 33923, 33924, 33925, 33926, 33927, 33928, 33929, 33930, 33931, 33932, 33933, 33934, 33935, and 33936.

33901 A LARGE LIQUID SCINTILLATOR FOR THE DETECTION OF ANTINEUTRINO REACTIONS. T. L.

Jenkins and F. Reines (Case Inst. of Tech., Cleveland). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 1-3(June 1964).

A 620 gallon liquid scintillator, used in the detection of the reaction of low-energy antineutrinos on protons and deuterons, is described. The response of the detector to gamma rays and other characteristics are given. (auth)

33902 ELECTRON RESPONSE OF NaI(Tl) AND A COMPARISON WITH ANTHRACENE AND PILOT B. Irvin S. Sherman, M. S. Freedman, F. T. Porter, and F. Wagner, Jr. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 20-3(June 1964).

An investigation was made of the relative response of NaI(Tl) to electrons over an energy range of 6 kev to 1 Mev. The light output at 6 kev is quite sensitive to the nature of the exposed surface. The results are given for the two best cleaved NaI(Tl) crystals and compared to the electron response deduced from photon data. There is good agreement above 20 kev, where little sensitivity to changes in surface conditions was observed. Similar measurements were made for anthracene and Pilot B. The relative light output per unit energy is shown for all three scintillators. Their merit as low energy electron detectors was found to be significantly affected by the amount of backscattering and the intensity and duration of long lived excitation states arising from ionizing events. (auth)

33903 RECENT PHOTOMULTIPLIER DEVELOPMENTS AT RCA. Robert M. Matheson (Radio Corporation of America, Lancaster, Penna.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 64-71(June 1964). (TID-20572)

Data on transit time and rise time for numerous types of photomultipliers are presented. Two new photomultipliers designed to provide superior time resolution are discussed. The properties of existing types designed for energy spectroscopy are reviewed. New types designed to reduce dark noise due to radioactive contaminants, dark current, and leakage are described and performance data presented. Some of the advantages of the K_2CsSb photocathode are shown. The development of photomultipliers for severe environments is reviewed. Two new families of tubes for this service are described. (auth)

33904 NEW DEVELOPMENTS IN RADIATION DETECTORS AND ELECTRON MULTIPLIERS. C. E. F. Misso and J. Z. Karpinski (CBS Labs., Stamford, Conn.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 72-5(June 1964).

Several electron devices for the detection of radiation are described. Discussed are a photomultiplier for UV and x-ray spectrum analysis which uses a switchable segmented photocathode; a large area scintillation counter tube which uses a large size multiplier structure giving it high coupling factor and high current capability; and a small, two terminal electron multiplier structure which uses an inclined strip of semiconductor material in an electric field. Illustrations and performance data are given. (auth)

33905 MULTIPLIER PHOTOTUBES FOR THE FAR ULTRAVIOLET. Martin Rome (Electro-Mechanical Research, Inc., Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 93-9(June 1964).

A new group of extreme solar-blind multiplier phototubes with cleaved lithium fluoride windows consisting of: end-on tubes with 28 mm active diameter cesium iodide and potassium bromide photocathode; 10 mm active diameter cesium iodide and copper iodide photocathodes; and a side-window tube with a cesium iodide reflective photocathode are described. The spectral responses have characteristic long wavelength cut-offs which serve as an efficient means of rejecting the scattered long-wavelength radiation in dispersive systems. The tubes have anode dark currents at room temperature equivalent to approximately one photoelectron per second. The count rate in the dark of cathode-originating electrons is 10-20 counts per minute. The pulse height distribution form photocathode illuminated with low-level ultraviolet shows an exponential form down to a small fraction ($1/_{25}$) of the average single electron pulse height. The highly ruggedized tubes are designed for the rigors of space applications. (auth)

33906 IMPROVEMENTS IN LIGHT AMPLIFIER OPERATION. P. C. Ruggles and N. A. Slark (English Electric Valve Co. Ltd., Chelmsford, Essex, Eng.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 100-7(June 1964).

The P.829 thin film light amplifier was greatly improved and was shown to be capable of providing very high photon gains exceeding 10^6, and low dark currents down to 3 scintillations/sq cm/sec. Under continuous operating conditions, a resolution exceeding 60 line pairs/mm was reported, and excellent pulsing characteristics were achieved at 20 nanoseconds exposure time. A tube incorporating a flat photocathode of 2" diameter and a first stage demagnification of 2 : 1 was made. Useful information was gained by using the P.829 type tube to study stellar spectra, Cherenkov rings, profiles of beams of charged particles, plasma physics, and bioluminescence. Some examples of photographic results obtained in these investigations are given. (auth)

33907 PROGRESS ON PHOTOMULTIPLIERS AND IMAGE INTENSIFIERS AT EMI ELECTRONICS LTD. V. A. Stanley (EMI Electronics Ltd., Ruislip, Middx, Eng.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 114-19(June 1964).

Recent work on photomultiplier tubes is reviewed. Dark current measurements by various techniques are presented, including data on tubes with high quantum efficiency and minimum thermionic emission suitable for low energy scintillation counting. Mention is made of a new fast tube, a small tube, and modified ion detectors. Two four-stage image intensifiers are described. (auth)

33908 THE PHOTON SCINTILLATOR. Martin Rome, R. V. Gauthier, and J. P. Causse (Electro-Mechanical Research, Inc., Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 120-8(June 1964).

A new sealed-off detector for accurate photon counting in the ultraviolet (1100-1800 Å) is described. The resultant pulse height distributions exhibit a clear separation between signal and multiplier dark current. At operating voltages of 20-25 kv across the photon scintillator the peak of the signal distribution occurs at pulse heights greater than 30 times that of the average single electron. Because of the broad valley between signal and dark current the counting rate is relatively insensitive to substantial changes in bias level. The integral background above the bias level due to both the photon scintillator and the coupled photomultiplier dark current is of the order of 1 count/sec or less. The pulse height resolution at 25 kv for low-light level ultraviolet radiation (single events) is approximately 45%. (auth)

33909 AN IMAGE INTENSIFIER SYSTEM FOR THE OBSERVATION OF NUCLEAR EVENTS. P. Iredale, G. W. Hinder, and D. J. Ryden (Atomic Energy Research Estab-

lishment, Harwell, Berks, Eng.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 139-46 (June 1964).

An image intensifier system is described in which a two-stage tube is coupled by a lens to a transmission-secondary emission type of intensifier with a grain of $>10^5$. The system has a large area input cathode and is intended to give a high efficiency of detection for photoelectrons originating from that cathode. It is intended that the system will be used to detect images at extremely low light levels, such as the ring image produced from a Cherenkov radiator by a lens or mirror. The experiments described concentrate on the performance of the system and its components. In particular measurements are made of the efficiency of detecting primary photoelectrons and of the accuracy in determining the position of an image. It is shown that for illumination in central regions of the photocathode ~2.5 spots of light are photographed on the output phosphor screen for each photoelectron. Approximately 1.8 are in a region surrounding the true image position and for a line image have a distribution with a standard deviation (referred to the input photocathode) of 2.7 mm. Of these ~0.5 are found to be bright spots in the correct image position. The remaining spots are widely distributed. Measurements were also made of the detection efficiency for single photoelectrons with the high gain image intensifier alone. For the conditions of the experiment it is found that only 30% produce a detectable signal in the correct image position. (auth)

33910 PROPERTIES, MECHANISM AND EXPERIMENTAL REDUCTION OF EFFECTS OF THE TIME-DEPENDENT FIELD EMISSION OF PHOTOMULTIPLIER TUBES. I. Cantarell (Puerto Rico Nuclear Center, Mayaguez). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 152-9(June 1964).

The hypothesis that photomultiplier fatigue is caused by the time-dependent accumulation of electric charge at the dynode surface is investigated. The corresponding equation contains two exponential terms for an observed double effect characteristic of phototube fatigue and of the Malter effect. A tentative interpretation of this double effect maintains that there are two successive jumps as the bound electrons of the MgO–Cs dynode escape from the F_2 or F_2^+ centers to the vacuum. Experimental measurements favor the calculations based on the proposed model, although there is no evidence for each particular level. To forestall fatigue effects preventive measures proved to be insufficient. However, tube gain stabilization can be achieved by a new method in minutes rather than the hours needed previously. Two further methods for correction of distorted energy spectra were developed. Several simple mechanical and electrical devices were developed for the automatic reduction of fatigue effects by compensation, to as little as 1% of the original values. This holds even in the case of strong sources. Also, methods of suppression of the fatigue phenomenon are discussed. The time dependent field emission equations play an essential role in this study. (auth)

33911 SECONDARY EMISSION STATISTICS— THEIR APPLICATION TO THE WINDOWLESS MULTIPLIERS. C. Julliot, M. Cantin, R. Ducros, C. Jehanno (CEA, Saclay, France). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 169-76(June 1964).

The statistical distribution of the secondary emission plays a very important part when using the windowless multiplier. A detailed study of the problem is presented. Results concerning the distribution of secondary electrons from impinging α-particles, the detection efficiency of the windowless multiplier, and the shape of the single electron spectrum are discussed. Comparison was made between experimental results and the predictions of the statistical theory. (auth)

33912 SEMICONDUCTOR LITHIUM-ION DRIFT DIODES AS HIGH-RESOLUTION GAMMA-RAY PAIR SPECTROMETERS. A. J. Tavendale (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 191-200(June 1964).

Germanium and silicon p-i-n diodes with active volumes up to 2 cm^3 were fabricated using the lithium-ion drift technique. Germanium doped with either gallium or zinc (5-10 ohm-cm) and boron-doped silicon (1100 ohm-cm) were the base materials. Diodes were operated at 77°K in conjunction with a low noise amplifier system. They were used as gamma-ray pair spectrometers, germanium diodes giving a resolution of 7 kev (FWHM) at 2.75 Mev gamma energy increasing to 10 kev at 7.64 Mev; resolution from a silicon device was slightly inferior. A germanium diode was used as the central detector in a triple-crystal pair spectrometer incorporating two NaI scintillators. This arrangement improved the ratio of the height of the pair peak to the background below the peak from 7 : 1 to 150 : 1 for 2.75-Mev gamma rays from a ^{24}Na source. (auth)

33913 HEAVY PARTICLE RADIATION DAMAGE EFFECTS IN LITHIUM-DRIFTED SILICON DETECTORS. Harry M. Mann and Jan L. Yntema (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 201-5(June 1964).

Deterioration of charged-particle resolution-width, for p-i-n detectors prepared by lithium-ion-drift techniques, was observed during bombardment with protons and alpha particles. During exposure the resolution-width increased without loss of rectification when damage was confined to the intrinsic region. Significant deterioration in response was observed for 10^8 particles/cm^2. Rapid loss of rectification was observed during exposure to neutrons at energies mostly in the range of from 1 to 10 Mev and for a flux of 10^9 neutrons/cm^2/sec. The damage effects were studied with several detectors having an electron resolution-width of 15 to 20 kev at room temperature, and a window thickness of approximately 1 mg/cm^2. Limitations on recovery, by further drift treatment, were observed for an integrated charged-particle flux in excess of 10^{12} particles/cm^2. The response of these detectors to electrons before and after damage and to heavy charged particles during production of damage and after recovery is described. (auth)

33914 RADIATION DAMAGE IN LITHIUM-DRIFTED p-i-n JUNCTIONS. J. A. Coleman and J. W. Rodgers (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 213-20(June 1964).

A major effect of radiation damage of semiconductor junction detectors is the decrease of charge carrier lifetime. The thick depletion regions and low fields usually employed in p-i-n junctions makes them particularly sensitive to radiation damage. A study of the changes of electron trapping lengths in silicon p-i-n junctions as a function of radiation damage by ^{60}Co gamma rays is presented. Significant changes of collection efficiency and collection time were observed at doses ($\sim 10^5$ r) which are considered negligible for damage in p-n junctions. The variations of reverse current and noise were small for these low doses. A method of fabrication and encapsulation of p-i-n junction radiation detectors is described which utilizes ion drifting

from a localized source of lithium and a gold–silicon alloy seal. (auth)

33915 MULTIPLICATION IN THE FISSION FRAGMENT PULSE-HEIGHT RESPONSE OF SILICON SURFACE BARRIERS. F. J. Walter (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 232-7(June 1964).

A number of investigators have observed multiplication phenomenon in the response of silicon surface barriers to fission fragments. In many cases, this multiplication is anomalous in the sense that it occurs at electric field intensities well below that required for avalanche multiplication. One group has suggested that this phenomenon is related to a threshold depth. However, other results from investigations of the response of surface barriers to fission fragments and heavy ions for a wide range of silicon resistivities and bias voltages have exhibited no systematic evidence to support the concept of a threshold depth. It is demonstrated that multiplications at anomalously low field strengths can be significantly reduced by surface treatment after fabrication and can be reduced or eliminated by the proper surface treatment and control of the thickness of the front electrode. A possible multiplication mechanism based on the concept of tunneling injection through the oxide layer is discussed in terms of these experimental results. Fabrication techniques which minimize the tendency to multiply, together with other detailed design criteria for optimizing the performance of fission fragment and heavy ion spectrometers, are also presented. (auth)

33916 THE ANOMALY IN THE RESPONSE OF SEMICONDUCTOR DETECTORS. W. R. Dodge, S. R. Domen, A. T. Hirshfeld, and D. D. Hoppes (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 238-43(June 1964).

Preliminary investigation of the response to beta and alpha particles of silicon radiation detectors cooled to temperatures below 77°K has led to the discovery of an anomaly in the pulse height distribution which is a function of detector temperature. The pulse height and resolution of a p-i-n lithium-drift silicon detector shows a rapid decrease in the temperature interval of 40–35°K for electric fields up to the maximum of 4200 volts/cm. Lithium-drift detectors of the p+-i-n surface barrier configuration exhibit similar characteristics. Surface barrier detectors of resistivities in the range of 3000 ohm-cm exposed to beta particles exhibit a decrease in pulse height and resolution in the temperature interval of 30–15°K. With increasing bias voltage the pulse height tends towards the high temperature values but with degraded resolution. A detailed investigation of the response of a surface barrier detector to alpha particles shows an anomaly of the same characteristics as the beta particle anomaly. In addition, the pulse height decreases at reduced bias voltages below approximately 14°K. A plausible explanation of the primary anomaly based on the analysis of Walter is discussed. (auth)

33917 THE CHANNELING OF IONS THROUGH SILICON DETECTORS. G. Dearnaley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 249-53 (June 1964).

Ion channeling in silicon single crystals is discussed, and an attempt is made to determine whether channeling effects are significant for protons. Experiments are described in which silicon crystals are used as an absorber and as a dE/dx detector for 2.1-Mev protons. Measurements were performed for various crystal orientations. (C.E.S.)

33918 HIGH-TEMPERATURE NUCLEAR PARTICLE DETECTOR. P. C. Canepa, P. Malinaric, R. B. Campbell, and J. Ostroski (Westinghouse Electric Corp., Pittsburgh). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 262-70(June 1964).

In many applications it is necessary to use sensors that are capable of operating in regions of either high ambient temperature or radiation flux or both. Such conditions may occur in reactor cores, casings of nuclear engines, etc. For applications of this type a nuclear particle detector was developed from silicon carbide which can detect charged particles, and, with the addition of a fissionable coating, thermal neutrons at temperatures in excess of 700°C. In a limited test of radiation resistance, selected diodes were irradiated up to 10^{14} protons/cm^2, with alternating irradiation and annealing. At this dosage, (roughly equivalent to 10^{16}nvt) some permanent degradation of the properties occurred. It was shown that the original perfection and the purity of the original crystal are of extreme importance in preparing the detector. The junction structure must also be tailored so that efficient counting is obtained. (auth)

33919 DETERMINATION OF TRANSIENT RESPONSE OF SEMICONDUCTOR DETECTORS BY USE OF A NANOSECOND-PULSE ELECTRON ACCELERATOR. Harry M. Mann and Irvin S. Sherman (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 271-5(June 1964).

An apparatus previously developed and used for determination of scintillator response characteristics was used for similar studies of the transient response of semiconductor nuclear detectors. With this apparatus a detector pulse as short as 1.2 nsec was observed. Pulses were recorded for diffused junction and lithium-drift diodes, in silicon. The effects of depletion-depth, base resistance, and electric field intensity in the depletion region are revealed in the shape of the pulse. The experimental method and the application of the apparatus to measurement of detector properties is discussed. (auth)

33920 THICK JUNCTIONS MADE WITH NUCLEAR-COMPENSATED SILICON. J. Messier, Y. Le Coroller, and J. Merlo Flores (CEN, Saclay, France). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 276-9(June 1964).

It is known that making detectors with great depletion depth is related to the availability of high resistivity Si, generally obtained by compensation. A new compensating technique, based on the production of P-31, in situ, by nuclear transmutation of Si by thermal neutrons is described. After annealing, very high resistivity Si was obtained by this method. Junctions with n-i-p structures with great depletion depth obtained by nuclear compensation are described, as an example of the possibilities of this new technique. (auth)

33921 JUNCTION COUNTERS PRODUCED BY ION IMPLANTATION DOPING. F. W. Martin, W. J. King, and S. Harrison (Ion Physics Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 280-5(June 1964).

Boron ions of 500 and 100 kev energy (0.7 microns and 0.14 microns range respectively) from a Van de Graaff accelerator were used to fabricate ½-inch diameter junction counters by bombarding the surface of etched 5000

Ω-cm and 10,000 Ω-cm n-type silicon slices. After being passed through an analyzing magnet to obtain a spectroscopically pure beam, the ions were scanned by electrostatic deflection plates to obtain uniform irradiation of the samples. Boron concentration could be varied as a function of depth in the crystal by programed rotation of the slices about an axis perpendicular to the beam. After post-irradiation annealing at 300°C to remove radiation damage, evaporated aluminum contacts were applied to the front and electroless nickel to the back. Initial investigation resulted in diodes with leakage as low as 10 μa at −100 volts and reverse breakdown voltage greater than −400 volts. The thinnest dead layer was 0.2 microns. Pulse height spectra taken with ^{210}Po alpha particles (5.3 Mev), in general contained large numbers of counts at low pulse heights, presumably due to carrier trapping in radiation-induced crystal defects. The best counter had a resolution of 50 kev with insignificant low energy noise. (auth)

33922 STABILIZATION OF LITHIUM-DRIFTED RADIATION DETECTORS. G. Norgate and R. J. McIntyre (RCA Victor Co., Ltd., Montreal). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 291-3(June 1964).

Ion-pairing occurs in silicon between lithium and acceptor impurities and causes a reduction in the effective diffusivity and drift-mobility of lithium. This effect was studied experimentally with different acceptor impurities. It appears that the suitable choice of an acceptor may, under certain conditions, result in at least an order of magnitude reduction. This is of interest in connection with lithium-drifted gamma detectors where a constant active volume must be maintained over long periods. (auth)

33923 SOME RECENT ADVANCES IN SPARK CHAMBER TECHNIQUES. Arthur Roberts (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 302-9(June 1964).

Advances in the technique and operation of spark chambers in high energy physics are reviewed. (auth)

33924 A STUDY OF SPATIAL ACCURACY IN A SYSTEM OF SPARK CHAMBERS. J. H. Christenson, A. R. Clark, and J. W. Cronin (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 310-16(June 1964).

A brief review of the spatial accuracy of spark chambers using various techniques for data extraction is presented. A detailed presentation of the accuracy obtainable using photography of spark chambers is given using the results obtained in recent experiments with two spark chamber spectrometers. In addition to a discussion of the jitter of individual sparks, the accuracy of the overall system is discussed. (auth)

33925 UNSCRAMBLING PULSE-HEIGHT SPECTRA ON-LINE. Robert W. Detenbeck (Naval Ordnance Lab., White Oak, Silver Spring, Md. and Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 344-8(June 1964).

In spite of the apparent complexity of the equations, it is shown that unscrambling scintillation spectra by a least-square-fit procedure is well suited to on-line calculations, requiring certainly no more than the very simplest of electronic computers. Unfortunately the sensitivity of the method to energy calibration errors limits its application to cases where the energies of the strong components in the spectrum are known beforehand. (auth)

33926 A RIGOROUS LEAST-SQUARES ANALYSIS OF COMPLEX GAMMA-RAY SPECTRA WITH PARTIAL COMPENSATION FOR INSTRUMENTAL INSTABILITY. Robert M. Parr and Henry F. Lucas, Jr. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 349-57(June 1964).

The least-squares method for analyzing multichannel gamma spectra is one of great power and versatility, but its full potential is difficult to realize due to instrumental instabilities. For sources having low or moderate activities and for which the counting times range from a few minutes to several hours, the most important instabilities are long term drifts in zero-energy channel-intercept and gain. A computer routine based on the use of a special reference source is described, which can detect changes in zero-intercept of as little as 0.05 channels (for a 512 channel analyzer), and in gain of as little as 0.1%. By prior transformation of the data to compensate for these effects, and by the use of appropriate weighting factors in the least-squares analysis, the goodness of fit is dramatically improved. Often, the goodness of fit indicator chi-squared over degrees of freedom is reduced from a value in excess of three, to a value which does not differ significantly from unity. The weighting procedure described takes into account the statistical errors in both the complex spectrum which is to be analyzed, and in the reference spectra which are its components. These computer methods were applied to the analysis of gamma spectra from biological materials containing low activities of the natural series of radionuclides and of atomic fallout products. (auth)

33927 A LOW-NOISE CHARGE-SENSITIVE PREAMPLIFIER WITH A FIELD-EFFECT TRANSISTOR IN THE INPUT STAGE. T. V. Blalock (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 365-72(June 1964).

The excellent energy resolution of semiconductor radiation detectors has generated a need for charge-sensitive transistorized preamplifiers that have low values of noise line-widths. The application of field-effect transistors in charge-sensitive configurations was investigated, and a low-noise preamplifier was consequently developed. The preamplifier has a junction field-effect transistor in the input stage. The field-effect transistor is connected in cascade with the second stage bipolar transistor which has its collector load bootstrapped by a White follower. The bias stabilization is adequate for normal operation of the preamplifier over an FET temperature range from room temperature to liquid nitrogen temperature. Measured values of the preamplifier noise line-width as a function of pulse-shaping time constants, total input capacitance, and temperature are presented. Formulas are included for the theoretical determination of the noise line-width. Application of the formulas requires knowledge of the parameters of the preamplifier and pulse-shaping circuitry and the noise characteristics of the FET. The FET noise characteristics are shown as experimentally determined graphs of narrow-band equivalent noise resistance versus frequency, temperature, and bias point. Preamplifier noise line-widths less than 1.6 kev fwhm for silicon detectors (189 rms electronic charges) and slopes less than 0.06 kev/pf (7.1 rms electronic charges per pf) were obtained when the FET was cooled to the optimum temperature which was approximately 125°K. (auth)

33928 DESIGN OF LOW-NOISE VACUUM-TUBE PULSE AMPLIFIERS FOR SEMICONDUCTOR RADIATION-DETECTOR SPECTROSCOPY. J. L. Blankenship (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 373-81(June 1964).

The pulse-height resolution of semiconductor radiation detectors for particle energies below 200 kev is primarily limited by detector and amplifier noise. Amplifier noise may be large compared to that contributed by cooled, deep-depletion-layer diodes, and minimum noise is achieved by optimizing amplifier design for specific diode parameters. Vacuum-tube performance is realistically evaluated by measuring equivalent noise resistances of both plate-current shot noise and grid-current noise as a function of plate current and by measuring the tube input capacitance under actual operating conditions. Nomographs were developed to solve the equations relating noise performance to all diode and amplifier parameters except flicker noise, which is negligible for low transconductance tubes in this application. Graphical noise calculation facilitates optimum amplifier design. These nomographs may also be used to calculate noise from field-effect transistors. By use of these nomographs, a vacuum-tube amplifier was designed which has a noise performance of 175 electronic charges rms (1.5 kev fwhm Si) for zero external capacitance and 225 electronic charges rms (2 kev Si) for 10 pf external capacitance. (auth)

33929 A HIGH-SPEED ANALOG PULSE DIVIDER. E. A. Gere and G. L. Miller (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 382-7(June 1964).

A high-speed analog pulse divider based on the reciprocal relation of diode impedance to diode current is described. The system may be used with semiconductor detectors for determining mass distribution in nuclear fission experiments. (C.E.S.)

33930 A VERSATILE SOLID-STATE TIME-TO-PULSE-HEIGHT CONVERTER. Ronald G. Roddick and Frank J. Lynch (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 399-405(June 1964).

A time-to-pulse-height converter was developed for use in delayed-coincidence as well as pulsed-beam experiments. It embodies advantages of both start-stop and overlap converters with a single-valued output. A constant current flows into a capacitor only when a fast bistable element is in the on condition. In the pulsed-beam mode of operation, the start pulse from the detector turns the bistable element on and the stop pulse derived from the r-f chopping signal turns it off. In the delayed-coincidence mode, the start pulse turns the bistable element on only if a ready pulse from a second detector is present, and it is turned off by the termination of the ready pulse, whose duration is determined by the length of a coaxial line shorted at one end. A means of gating the timing pulses by a fast integral gate is provided to reduce the duty cycle. (auth)

33931 A SINGLE-VALUED TIME-TO-PULSE-HEIGHT SYSTEM USING TUNNEL DIODES. H. L. Weisberg and S. Berko (Brandeis Univ., Waltham, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 406-8(June 1964).

Several aspects of interest in a new delayed coincidence apparatus are described. A tunnel diode time to pulse height converter was built having an inherently single-valued response, rather than the usual double-valued one. The circuit built has an inherent time resolution (full width at half maximum) of 40 psec. The method used to obtain an accurate time calibration and detect small non-linearities in the system response is discussed. A pile-up detector, consisting of a univibrator, an integrator, and a biased diode discriminator is also discussed. Using Naton 136 plastic scintillators, RCA 7850 photomultipliers, zero-crossing triggers and pulse height compensation, ^{60}Co resolution curves having a f.w.h.m. of 250 psec and covering more than four decades are obtained. (auth)

33932 PARTICLE DISCRIMINATION BY TIME-OF-FLIGHT METHODS. D. S. Gemmell (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 409-14(June 1964).

A time-of-flight technique was used to discriminate between particles of differing masses which are emitted from nuclear reactions. The particles are detected with a silicon junction counter. A two-parameter pulse-height analyzer is used to record both the energy and the flight time of each particle detected. The Argonne tandem Van de Graaff provides a chopped and bunched incident beam. Pulses from the silicon detector are fed into both a fast (200-Mc band width) amplifier and into a conventional charge-sensitive preamplifier with a slower response. The fast side of the circuit feeds into a time-to-pulse-height converter giving a pulse which is a measure of flight time. An energy pulse is provided by the slower circuitry. The experimental data show a time resolution of 2 nsec and an energy resolution of 50 kev for particles with energies between 400 kev and 10 Mev. (auth)

33933 A LOW BACKGROUND ALPHA SCINTILLATION COUNTER. Robert F. Dvorak and Richard W. Fergus (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 415-19(June 1964).

An alpha scintillation counter was developed that exhibits unusually good characteristics for routine counting of low activity samples. The detector is a phoswich consisting of a 0.0008-inch thick CsI crystal mounted on 0.020-inch thick Pilot B discriminator. Optical coupling to the RCA 7746 photomultiplier is through a Lucite light pipe. The sensitive area of the detector is 2 inches in diameter, permitting use of a large sample pan. Counting efficiency, relative to that of a 2π windowless proportional counter, is about 86 per cent for a thin plutonium-239 source, and about 65 per cent for an infinitely thick alpha source (uranium-235 dispersed in lucite). Typical background for an uncontaminated detector ranges from $\frac{1}{4}$ to $\frac{1}{3}$ count per hour. The detector face can be decontaminated using tissue and ethyl alcohol with no apparent deleterious effects. The electronic circuitry analyzes each pulse to determine rise time, peak current, and integrated current. Since the ratio of peak to integrated current is a characteristic of the scintillator, and is quite different for pulses from the two materials utilized, it is possible to identify pulses occurring only in the CsI, where all of the alpha particles are stopped. The rise time circuit verifies absence of a simultaneous Pilot B pulse and aids in rejection of certain types of noise. (auth)

33934 A STABILIZED SCINTILLATION COUNTER. P. F. Hinrichsen (Bartol Research Foundation, Swarthmore, Penna.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 420-5(June 1964).

A gain stabilization system for use with a scintillation counter is described. The system uses a ^{210}Po α source sandwiched between two 0.020" thick discs of plastic phosphor as a reference light source, which is mounted between the NaI(Tl) crystal and the photomultiplier. This produces a stable Gaussian reference peak in the pulse height distribution, equivalent to 150-kev γ rays. A simple pulse shape discrimination circuit at the photomultiplier anode gates the circuitry such that it only responds to the reference pulses, thus making the system independent of any changes in the γ flux. (auth)

33935 SATELLITE INSTRUMENTATION FOR THE MEASUREMENT OF AURORAL PHENOMENON. J. B.

Reagan, D. L. Carr, J. D. McDaniel, and L. F. Smith (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 441-5(June 1964).

A variety of instruments were employed aboard earth-orbiting polar satellites for measurements of the aurora phenomenon. Fixed-threshold total-energy detectors which utilize aluminum layers evaporated onto plastic scintillators for electron threshold determination in the 2-31 kev range and a photomultiplier operated in a constant current mode for viewing the scintillation light are described. A variable-energy detector which utilizes a programmed variable-energy threshold and post acceleration to detect electrons in the 80 ev to 1.6 kev energy range is also presented. The satellite data handling system for obtaining high spatial resolution is described. (auth)

33936 HIGH STABILITY MULTIPARAMETRIC MODULAR CIRCUITRY USED IN THE EXPERIMENTS AT THE SACLAY'S CYCLOTRON. R. Chaminade, A. Falcoz, M. Lechaczynski, and J. Pain (CEN, Saclay, France). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 3, 446-56(June 1964).

Advent of the small semiconductor detector makes easier complex multiparametric experiments which may include a great number of detectors to provide precise information on location and energy of particles. Such complex systems pose special requirements for reliable, flexible, and high performance electronics. A set of modular circuits was designed for use at the Saclay cyclotron which may be assembled easily for either simple or complex experiments. The following modular and sub-modular circuits are described: charge-sensitive preamplifier module, highly stable gain, low noise, 15 nsec minimum rise time charge-sensitive preamplifier submodule, preamplifier-associated discriminator module, 4-input, low noise, stable, low level linear mixer, low level discriminator to be driven directly from the above preamplifiers, precision, semi-fast high level discriminator, 3-input, highly stable gain, gated linear amplifier with precision, continuously adjustable gain, 4-input, high level linear mixer and biased post amplifier, and automatic testing system. The modules are described, and the application of the modular system is illustrated in connection with nuclear spectroscopy experiments employing $\alpha\alpha'$-scattering. (auth)

33937 A HIGH-LEVEL WHOLE-BODY COUNTER. A. C. Morris, Jr., D. A. Ross, and J. C. Travis (Oak Ridge Inst. of Nuclear Studies, Tenn.). Intern. J. Appl. Radiation Isotopes, 15: 391-6(July 1964).

A whole-body counter measuring an activity range from 150 mc down to 10 μc for γ-emitting radioisotopes is in clinical use. Several designs were considered and the detection uniformity for each system was measured. The accepted design uses a collimated detector mounted 9 ft above a prone or supine subject. Whole-body retention counts can be performed in 1 min for activities greater than 50 μc; 10-min counts are required for 10 μc. (auth)

33938 LIQUID SCINTILLATION SOLVENT SYSTEMS: WATER CONTENT AND RELATED COUNTING EFFICIENCIES. J. A. Baxter, L. E. Fanning, and H. A. Swartz (Butler Univ., Indianapolis). Intern. J. Appl. Radiation Isotopes, 15: 415-18(July 1964).

The figure of merit, the product of the percentage total water content and the counting efficiency, was employed to evaluate selected liquid scintillation solvent systems for the counting of ^{14}C and tritium aqueous samples. The maximum observed values at room temperature, 5 to 0°C and −15°C, were 281.8, 313.5, and 493.5 for ^{14}C, and 55.8, 76.9, and 179.7 for tritium, respectively. (auth)

33939 EVALUATION OF ORGANOMETALLICS IN PLASTIC SCINTILLATORS TOWARD γ-RADIATION. S. R. Sandler and K. C. Tsou (Borden Chemical Co., Philadelphia). Intern. J. Appl. Radiation Isotopes, 15: 419-26 (July 1964).

Organometallic compounds and monomers were synthesized and incorporated into scintillation plastics. Scintillation plastics made from 50 or 60% p-triphenyltinstyrene-2,4-dimethylstyrene copolymers showed a distinct photopeak when evaluated toward ^{57}Co gamma radiation and ^{137}Cs gamma radiation using a 400 multichannel analyzer. (auth)

33940 SCINTILLATION CAMERA WITH MULTICHANNEL COLLIMATORS. Hal O. Anger (Univ. of California, Berkeley). J. Nucl. Med., 5: 515-31(July 1964). (UCRL-11335)

The sensitivity of the scintillation camera when it is used with multichannel collimators is appreciably higher than focused-collimator mechanical scanners. The resulting greater speed with which pictures can be taken is a decided advantage in clinical situations. A number of different views can be taken if desired, and the examination can still be completed in a relatively short time. Alternatively, the amount of radioactive tracer can be reduced to minimize the radiation dose to the patient. The scintillation camera has the further advantage that it is continuously sensitive to all parts of the subject within its field of view. Tracer compounds with short effective half lives can be used without the distortion inherent in scanners. Because of this and the high sensitivity, rapid sequences of still pictures or time-lapse movies can be taken to show the function of an organ. (auth)

33941 A REMARK TO A FORMULA IN K. ISHIMATSU'S PAPER ON "CONTINUOUS γ-RAY SPECTROMETRY WITH SCINTILLATION COUNTERS." Alfred Schaarschmidt (Johann-Wolfgang-Goethe Universitat, Frankfurt am Main). J. Nucl. Sci. Technol. (Tokyo), 1: 27-8(Apr. 1964).

In evaluating the efficiency of an NaI(Tl) crystal in an extended gamma field, Ishimatsu replaced the cylindrical crystal by an imaginary spherical crystal. Errors in the expression used for the limiting radius of the equivalent sphere are noted, and a corrected expression is obtained. (D.C.W.)

33942 PROOF OF OPERATION OF A CLOUD CHAMBER AT LOW HELIUM PRESSURE. S. Barkan (Univ. of Istanbul). J. Phys. (Paris), 25: Suppl. to No. 3, 49A-50A (Mar. 1964). (In French)

A diffusion cloud chamber containing helium was successfully operated with pressures as low as 10 cm of Hg by an appropriate selection of available parameters. The effects of sweeping field and temperature were examined, with emphasis on the importance of the sign and strength of the sweeping field. (D.C.W.)

33943 ASSEMBLY FOR MEASUREMENTS IN 4π GEOMETRY ON SAMPLES WITH WEAK BETA ACTIVITY. HALFLIFE OF ^{110m}Ag. J. Colomer and M. Valentin. J. Phys. (Paris), 25: Suppl. to No. 3, 57A-60A (Mar. 1964). (In French)

An assembly is described in which a low background is obtained by using a lead housing and operating the 4π β counter in anticoincidence with a plastic scintillator. Operation of the assembly and its background are discussed, and the results of a half-life measurement on ^{110m}Ag are presented by way of illustration. The half life was found

to be 295 ± 7 days, with a 4π background of 0.37 c/min/cm^2. (D.C.W.)

33944 FAST NEUTRON TIME-OF-FLIGHT SYSTEM FOR USE WITH 16'' VARIABLE ENERGY CYCLOTRON. Shinsaku Kobayashi, Hajime Ohnuma, Akira Uchida, and Minoru Imaizumi (Tokyo Univ.). Japan. J. Appl. Phys., 3: 320-5(June 1964).

The neutron time-of-flight system used with the variable-energy cyclotron of the University of Tokyo is described. A proton beam with a peak current of about 400 μamp is obtained with a duration of less than 2 nsec (natural bunching) and a reduced repetition frequency of 3 Mc at the neutron producing target. The overall time resolution obtained with the system is 4 nsec for 1 Mev neutrons. (auth)

33945 PULSE-HEIGHT DEFECTS IN SEMICONDUCTOR DETECTORS FOR FISSION FRAGMENTS. Shoji Shirato (St. Paul's Univ., Tokyo). Japan. J. Appl. Phys., 3: 326-34 (June 1964).

The response of surface-barrier detectors to fission fragments was measured as a function of the bias voltage applied to the detectors. It was found that the reciprocal of pulse height decreases linearly with decrease of the reciprocal of the average electric field strength within the depletion region. In accordance with such saturation characteristics, the pulse height defect for fission fragments was shown to decrease approximately linearly with decrease of the reciprocal of the electric field. By extrapolation of the linear relation to the infinite field strength, the pulse height defect for each group of light and heavy fragments was separated into field-dependent and -independent components. The defect obtained at a finite field strength is a few Mev greater for heavy fragments than for light ones, the difference coming mainly from the field-independent component. The field-independent defect seems to be smaller than the ionization defect in gas. Possible causes of the pulse height defect are discussed. (auth)

33946 THE ABSOLUTE ACTIVITY MEASUREMENT OF β EMITTER RADIOELEMENT. THE CASE OF 4π COUNTERS. R. Touzin and J. Chatelet. Microtecnic, 17: 22-6(1963).

Methods permitting the direct measurement of the number of disintegrations undergone by a radioactive source are discussed, with particular attention given to the method using 4π counters. However, only the case of pure β emitters was investigated. It was concluded that excellent precision can be achieved with $4\pi\beta$ counters, and more particularly proportional $4\pi\beta$ counters. (P.C.H.)

33947 A 50-CM DOUBLE FOCUSING BETA SPECTROMETER OF THE CURRENT SHEET TYPE. K. Siegbahn, C. Nordling, S.-E. Karlsson, S. Hagstroem, A. Fahlman, and I. Andersson (Univ. of Uppsala). Nucl. Instr. Methods, 27: 173-89(May 1964).

An air-cored, double-focusing beta spectrometer is described, in which the magnetic field is generated by two coaxial cylindrical coils. The solid angle accepted by the spectrometer is 0.3% of 4π at a resolution of 0.2% and 0.05% at a resolution of 0.02%. Current regulation and data recording are completely automatic as well as the cooling system for the spectrometer coils. The maximum electron energy of the instrument is 3.5 Mev. A relative width of 0.012% is obtained for the I-line of ThB. With a mass-separated source of ^{133}Xe, a conversion electron spectrum from the K, L, M, and N shells is obtained in which eight components are observed at a resolution of 0.04%. (auth)

33948 HIGH PRECISION PRISM BETA SPECTROMETER. V. M. Kelman, B. P. Peregood, and V. I. Skopina (Leningrad Inst. of Physics and Tech.). Nucl. Instr. Methods, 27: 190-210(May 1964).

A magnetic beta spectrometer with an electron optical diagram similar to that of optical spectrometers is described. The magnitude of the solid angle used can be varied from 0.005 to 0.8% from 4π, the corresponding resolving power values changing from 0.014 to 0.2%. The relative instrumental half-width of conversion lines does not depend on energy. The accuracy of energy determination is 0.02%. The instrument control and data recording are fully automatic. The background was reduced to 5 counts per hour. (auth)

33949 A POLARISATION ANALYSER FOR PROTONS WITH ENERGIES BETWEEN 15 AND 30 Mev. G. J. Lush, T. C. Griffith, and D. C. Imrie (University Coll., London). Nucl. Instr. Methods, 27: 229-34(May 1964).

A polarization analyzer for protons with energies in the region 15–30 Mev and having an analyzing power greater than 50% at 20 Mev is described. The analyzer uses helium gas at a pressure of 30 atm and uses the high polarization that results from elastic scattering at angles of 60 and 120°. Details of the analyzer construction and of its calibration with 20, 25 and 30 Mev protons are given, and the calibration results are compared with a Monte Carlo calculation of the analyzing power. (auth)

33950 PROPOSAL FOR A VERSATILE COINCIDENCE SPECTROMETER EMPLOYING AN ANTI-COMPTON ANNULUS. J. Kantele and O. J. Marttila (Univ. of Helsinki). Nucl. Instr. Methods, 27: 235-6(May 1964).

The use of an anti-Compton mantle in conjunction with coincidence measurements is proposed, with special reference to high-efficiency, sum-peak coincidence spectrometry. (auth)

33951 APPLICATIONS OF THE DOUBLE MODERATOR DE PANGHER NEUTRON DOSIMETER NEAR ACCELERATORS. W. C. Day and R. L. Kathren (Univ. of California, Livermore). Nucl. Instr. Methods, 27: 237-42(May 1964). (UCRL-7208)

A modified DePangher double-moderator BF_3 detector was used to measure stray fast neutron fields outside the biological shielding of a Cockcroft-Walton ion generator, a cyclotron, and a linear accelerator. The instrument measures RBE dose rate between 0.1 and 5 Mev and average energy of the epicadmium neutron spectrum. Stray neutron fields of <1 mrem/hr were detectable and "sky shine" from an accelerator without roof shielding was characterized. Such fields were not accurately measured with ordinary survey instruments. The average energy of stray neutrons outside accelerator shields was found to be approximately 0.8 Mev. Characteristics and limitations of the detector are discussed, including the use of gated pulse techniques for neutron measurement in high intensity pulsed gamma fields. (auth)

33952 GEOMETRICAL CORRECTIONS IN TRIPLE-CORRELATION EXPERIMENTS. P. R. Chagnon (Univ. of Notre Dame, Ind.). Nucl. Instr. Methods, 27: 266-8 (May 1964).

The method of Feingold and Frankel was extended to calculate geometrical corrections in triple directional correlation experiments involving a point source and two axially symmetric movable detectors. It is shown that the correction factors are products of the factors used in double correlation experiments. (auth)

33953 A NEW LIQUID SCINTILLATOR FOR THERMAL NEUTRON DETECTION. H. H. Ross and R. E.

Yerick (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 20: 23-7(Sept. 1964).

A liquid-scintillator system was developed for the detection of thermal neutrons. The method employs the $^{6}Li(n,\alpha)^{3}H$ reaction; the resulting tritons and alpha particles interact with the scintillator to produce light photons which are detected in the usual manner. ^{6}Li salicylate is used as the active component of the scintillating solution and is unusual in that it serves not only as a target for the reaction but also serves as the solution fluor. The various characteristics and properties of the system are described. (auth)

33954 FIELD-STRENGTH RELATIONSHIPS FOR SILICON SURFACE-BARRIER DETECTORS. John P. Adams (Oak Ridge Technical Enterprises Corp., Tenn.). Nucleonics, 22: 112-13(Aug. 1964).

For effective utilization of silicon surface-barrier detectors it is necessary to determine the appropriate combination of detector parameters. The curves presented for n-type silicon permit rapid determination of the parameters. The electric field strength in these devices must be sufficient to ensure good charge collection while remaining well below the critical level for avalanche breakdown in silicon. For a known resistivity the curves can be used to determine the applied bias voltage, the maximum electric field strength, the depletion depth required to stop the particle, the capacitance per unit area, and the maximum energy of the particle that will be stopped within the sensitive volume of the detector. (C.E.S.)

33955 CORRELATED ENERGY AND TIME-OF-FLIGHT MEASUREMENTS OF FISSION FRAGMENTS WITH SEMICONDUCTOR DETECTORS: SYSTEM DESIGN AND PERFORMANCE. C. W. Williams, W. E. Kiker, and H. W. Schmitt (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 35: 1116-23(Sept. 1964).

A system for the measurement of correlated energies and times-of-flight of fission fragments was developed. This system, adaptable for use with other charged particles as well, includes a fast-response transformer coupling scheme in which the charge originating in a solid-state detector passes through the transformer primary to a low noise charge-sensitive amplifier; the fast timing signal is obtained from the transformer secondary. Noise thereby added to the linear energy signal is negligible. The measured time resolution of the system for particles in a narrow band of energies was $\leq$0.4 nsec, full-width at half-maximum. The design of the system is described, and the detailed results of performance tests, including tests with coincident ^{252}Cf spontaneous fission fragments and energy-time correlation measurements for bromine and iodine ions (artificial fission fragments), are given. (auth)

33956 HIGH SPEED DECADE PULSE COUNTING. R. S. Foote and D. Johnson (Texas Instruments, Inc., Dallas). Rev. Sci. Instr., 35: 1126-9(Sept. 1964).

A high speed decade counter was developed for pulse counting from single pulse to repetition rates greater than 50 Mc. The circuit incorporates a ladder of five tunnel diodes integrated with a rapid reset, followed by a countdown of two. Direct indicator tube readout of the pulse count is accomplished by voltage-to-digital conversion. (auth)

33957 SCANNING AND MEASURING PROJECTOR. P. G. Davey, R. I. Hulsizer, W. E. Humphrey, J. H. Munson, R. R. Ross, and A. J. Schwemin (Univ. of California, Berkeley). Rev. Sci. Instr., 35: 1134-46(Sept. 1964). (UCRL-11154(Rev.))

The Scanning and Measuring Projector (SMP) is a semi-automatic device for making rapid and accurate measurements on bubble chamber or other photographs. The SMP, its human operator, and a general purpose digital computer work together in an integrated system. The operator scans the film and specifies the approximate path of the points to be measured, and the points are accurately digitized by a novel apparatus that sweeps the specified portion of the image across a fixed lattice of reference marks. The SMP digitizing mechanism and process, and the configuration of the over-all system are described. Also discussed are the pattern-recognition and time-sharing aspects of the associated computer program, and its error-correcting capabilities. (auth)

33958 TIME-SHARED TIME-OF-FLIGHT ANALYSIS BY COMPUTER. R. E. Chrien, S. Rankowitz, and R. J. Spinrad (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr., 35: 1150-6(Sept. 1964). (BNL-7744; BNL-7744-R)

A time-shared computer-centered data collection system was placed into operation. The system provides simultaneous data collection and sorting for two physically unrelated neutron time-of-flight experiments in time-share with a general computation facility. A general purpose stored-program digital computer with a 4096 word, 24-bit memory is the heart of the system. The computer system provides, for the fast neutron chopper experiment, a 1024-channel time analyzer for total or partial neutron cross section experiments, three elapsed-time clocks, three total events scalers, two monitor scalers, and a chopper tachometer. At the same time, for the slow neutron chopper experiment, the system provides a 256-channel time analyzer, a clock, a total events scaler, a monitor scaler, and a chopper tachometer. The two experiments are independent of one another and are controlled by the typing of four-letter mnemonic codes on the system typewriter. A live cathode-ray tube display of either experiment is present at all times except when the time-shared computational facility is being used. Connections between the computer and the external analog-to-digital converters are made on a patchboard, allowing convenient control of data format. The system was designed to facilitate expansion to multiparameter data handling. (auth)

33959 INTERNAL PULSE AMPLIFICATION IN SILICON p-n JUNCTION RADIATION DETECTION JUNCTIONS. Gerald C. Huth, James B. Trice, and Russell A. McKinney (General Electric Co., Valley Forge, Penna.). Rev. Sci. Instr., 35: 1220-2(Sept. 1964).

Internal pulse amplification in silicon p-n junction radiation detectors was observed in the energy range from 0.05 to 1.0 Mev incident. The detectors are operated in the preavalanche region with significant multiplication occurring at internal electric field values of greater than 150 kv/cm. Pulse risetimes as fast as 4 nsec were measured for internally amplified pulses. (auth)

33960 PROGRAMMER FOR A TWO-DIMENSIONAL PULSE-HEIGHT ANALYZER. T. J. Kennett (McMaster Univ., Hamilton, Ont.). Rev. Sci. Instr., 35: 1230-1(Sept. 1964).

The design and performance of an external programmer for a 1024-channel analyzer arranged in a 32 × 32 channel a array are described. A transistor-diode-logic system was employed. (C.E.S.)

33961 PHOTOMULTIPLIER TRANSIT TIMES. Martin Feldman (Univ. of Pennsylvania, Philadelphia). Rev. Sci. Instr., 35: 1238-9(Sept. 1964).

A simple relation between the transit time of the elec-

trons in a photomultiplier and the photomultiplier supply voltage is discussed. Applications of this relation to compensate for the change in photomultiplier gain or to adjust delays in a fast coincidence system to compensate for changes in the supply voltage are considered. (C.E.S.)

33962 ON THE DEVELOPMENT BY BROMINATION OF A HYDROSOL OF SILVER, OF NEW NUCLEAR EMULSIONS OF HIGH SENSITIVITY. Jean-Claude Fayolle. [Sci. Ind. Phot., 33: 313-28(1962)]. (In French)

Techniques to improve the quality of emulsions obtained by bromination of a silver hydrosol dispersed in gelatin, especially the sensitivity, were studied. The chemical effects acting on the sensitivity and the fogging of the emulsions were investigated in order to obtain the optimum sensitivity compatible with a minimum fogging grain density. The technique for the preparation of the emulsions was improved, and possible augmentation of the sensitivity by increase of the size of silver bromide crystals was then studied. A technique for the bromination was devised that resulted in a slight increase in crystal size. The effect of various factors, such as method of measurement, nature of gelatin, method of sensitization, and method of development on the grain density was determined. (J.S.R.)

33963 SPURIOUS SCATTERING IN PHOTOGRAPHIC NUCLEAR EMULSION. Robert Delessert (Laboratoire de Recherches Nucleaires, E.P.U.L., Lausanne, Switzerland). Sci. Ind. Phot. (2), 34: 221-30(Aug. 1963). (In French)

Spurious scattering in Ilford K5 (600 μm) emulsions, irradiated and then mounted on glass, was studied as a function of geometrical parameters: cell length, tracks dip and depth, as well as a function of different factors of the processing such as conditions of presoaking, temperature of dry hot stage, silver concentration in the fixing bath, and drying conditions. (auth)

33964 APPLICATION OF GENERATING FUNCTIONS OF PROBABILITY THEORY TO THE STATISTICS OF NUCLEAR PARTICLE COUNTING AND PULSE SPECTROMETRY. Lothar Weise. Z. Instrumentenk., 71: No. 3, 59-66(1963). (In German)

Generating functions of probability theory are an auxiliary in the description of statistical procedures. Their application to the statistics of multiplication processes, as for example, in scintillation counters and proportional counters, is of great importance. The practical utility of the formalism for the statistics of nuclear particle counting and pulse spectrometry are illustrated by characteristic examples. (tr-auth)

33965 A STREAMER CHAMBER. B. Dolgoshein, B. Luchkov, and B. Rodionov (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 46: 1953-9(June 1964). (In Russian)

A new type of gas discharge track chamber is described which efficiently records charged particles irrespective of their direction of motion within the chamber. The mechanism of formation of the particle tracks is discussed. Characteristics of the chamber and the results of investigation of various gas fillings are presented. (auth)

33966 SHOWER EFFICIENCY OF A SPARK CHAMBER. V. N. Bolotov and M. I. Devishev (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 46: 1990-5(June 1964). (In Russian)

The counting efficiency for shower particles traversing a spark chamber with a large electrode gap is measured. The dependence of the efficiency on the number of shower particles, chamber entrance angle, and chamber energizing conditions is presented. (auth)

33967 NUCLEAR RADIATION DETECTORS. Jack Sharpe. Methuen's Monographs on Physical Subjects. New York, John Wiley and Sons, Inc., Publishers, 1964. 247p. $4.95.

After a brief review on the interactions of nuclear radiation with matter and on the properties of detection media, the efficiency of detectors is discussed, together with the principles, design, and characteristics of secondary emission multipliers, scintillation counters, and ionization devices. (D.C.W.)

33968 THE COLOURED MULTISCINTIGRAM SYSTEM. M. Ozeki and Y. Furukawa (Kurume Univ., Jurume City, Japan). Vienna, International Atomic Energy Agency, 1964, Preprint SM-51/9, 20p. (CONF-453-6)

From IAEA Symposium on Medical Radioisotope Scanning, Athens, Apr. 1964.

The visualization of isotope distribution is an important aspect of the medical use of isotopes. Conventional monochrome (black and white) scintigrams show insufficient contrast, even if this is improved by contrast expansion or background erasure techniques. To obtain satisfactory visualization, the scintigram should be displayed in colored form, the variation of the colors being controlled by the count rate due to radioactivity in the object. An assembly for recording colored stintigrams, called the multiscintigram system, is described. This assembly can readily be used to adapt a conventional (monochromatic) scinti-scanner with a spectrometer, so as to provide colored scintigrams very economically. The device is stable in operation and multiple copies of scintigrams can be obtained with it. The multiscintigram system assembly consists of the multiscintigram controller and the scintigram recording circuits. These units may be added to an existing scinti-scanner. A specific color is given to each of the scintigram recording circuits, each having a different color. Accordingly, the number of the available colors is equal to the number of the scintigram recording circuits, which operate in sequence over ranges of count rate. These ranges are pre-set and their operations are controlled by the multiscintigram controller circuit. The latter circuit computes the count rate of input pulses fed through the spectrometer and automatically selects one of the scintigram recording circuits, operating in the range within which the count rate falls. This circuit then operates while the other ones remain idle. Thus, a series of sectional scintigrams is obtained, each corresponding to the range of one of the scintigram recording circuits. All the sectional scintigrams are printed on the paper at equivalent positions, so that the colored scintigram can be built up. In the present scintigram recording device a tapping solenoid is used with spirit carbon papers as the color medium. A notable feature of the multiscintigram system is the possibility to use the colored scintigrams for routine clinical diagnostic applications. If both the colored scintigram and the sectional scintigrams are observed, it is easy to find any abnormal variation of the isotopic distribution in the subject. This leads to increasing accuracy of diagnosis. The system was used for clinical diagnosis of brain tumors and the investigation of diseases of thyroid, liver, and kidney. (auth)

33969 A COMPARISON BETWEEN COLLIMATOR THEORY, EXTENDED TO ALLOW FOR THE EFFECT OF WALL PENETRATION, AND EXPERIMENT. H. A. B. Simons (Royal Free Hospital School of Medicine, London).

Vienna, International Atomic Energy Agency, 1964, Preprint SM-51/28, 33p. (CONF-453-14)

From IAEA Symposium on Medical Radioisotope Scanning, Athens, Apr. 1964.

The response of a collimator to a point source of radiation moving on a line perpendicular to the axis of the collimator may be determined by calculating the variation of the solid angle subtended by the exit pupil of the collimating hole at the source. The experimental response curves so determined are always broader than the theoretical curves, principally because of the effect of penetration of quanta through the material of the collimator wall. The magnitude of the penetration effect has been calculated for a cylindrical hole both for points lying within the umbra and within the penumbra of the hole. Numerical values are given for a point source on a plane perpendicular to the axis of the hole in terms of the dimensionless parameters d/r and μH where d is the perpendicular distance of the source from the axis of a hole of radius r, μ the linear absorption coefficient of the collimator material and H the perpendicular distance of the source from the exit pupil. These calculations have been extended to the case of a hole in the form of a truncated cone where the source plane coincides with the focal plane of the cone. Experimental response curves have been measured for cylindrical and conical holes for sources of different quantum energy. These may be compared with theoretical curves obtained after allowing for the penetration effect. The magnitude of the ratio, f, of the number of quanta penetrating the collimator wall to those passing through the exit pupil of the hole has been measured for a point source on the axis of a cylindrical hole for different quantum energies and is in reasonable agreement with theoretical values. The response curves for a point source, allowing for collimator penetration, are applied to the calculation of the figure of merit of Dewey and Sinclair of some simple collimator systems for plane sources of varying target diameter and quantum energy. (auth)

33970 A PROPOSED ORBITING X-RAY TELESCOPE. K. Ziock (Univ. of Virginia, Charlottesville). 12p. (CONF-452-22)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

Choice of materials and projected performance of a totally reflecting x-ray telescope for space uses are discussed. (R.E.U.)

33971 AN AUTOMATIC MEASURING AND GAP COUNTING MACHINE FOR BUBBLE CHAMBER PICTURES. Basharat A. Munir. 9p. (CONF-452-19)

From American Physical Society, Washington, D. C., Apr. 1964.

A system is described which can measure the gap density distribution of tracks, while simultaneously recording x-y coordinates along the tracks. The system, which can be adapted to a conventional measuring projector, thereby increasing machine speed by at least a factor of two, uses a track centering device that measures the distance of the center of the track in microns from a reference point. This correction is added to the readings of the digitizers that record the position of the reference point. (D.C.W.)

33972 A LARGE APERTURE TIME-OF-FLIGHT COUNTER SYSTEM. C. Ward, A. Berick, E. Tagliaferri, and C. York (Univ. of California, Los Angeles). 30p. (CONF-452-33) (UCLA-1008)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

A time-of-flight system having a resolution of 0.9 nsec and using scintillation counters 4" × 12" in area was developed. The system employs RCA 7850 photomultiplier tubes, and was tested with three different thicknesses of plastic scintillator. The scheme of Charpak, Dick, and Feuvrais was used to eliminate the time variations due to the velocity of propagation of the light signals through the scintillator. The system was tested using an external electron beam, an electron synchrotron and a ^{90}Sr source. The system is described in detail together with an analysis of factors that contribute to the overall resolution of 0.9 nsec. (auth)

33973 IMPROVEMENTS RELATING TO RADIOACTIVITY CONTAMINATION MONITORS. James Robert Brown and Jack Sharp (to Electrical Musical Industries, Ltd.). British Patent 963,580. July 15, 1964. Filed Oct. 6, 1959.

A contamination monitor is designed for distinguishing between α and β radioactivity. The monitor includes a portable probe of the dual-phosphor scintillation type and means for producing audible signals in reponse to α and β particles, the signals being distinctive (sqeaks and clicks) with respect to α and β particles. The instrumentation portion of the monitor includes trigger circuits, anticoincidence circuit, tone circuit, ratemeter, and mechanical register. (D.L.C.)

33974 APPARATUS FOR THE MEASUREMENT OF LOW LEVELS OF BETA-RADIOACTIVITY IN LIQUIDS. (to Ceskoslovenska Akademie VED). British Patent 963,642. July 15, 1964. Priority date Apr. 26, 1960, Czechoslovakia.

A scintillation apparatus for measuring directly low beta activities in water and other liquids is described which gives more accurate results than the evaporation method. The apparatus comprises an exchangeable transparent vessel inserted between two photomultipliers connected into a coincidence circuit and screened with an anticoincidence ring of detectors. The vessel is shaped to hold a very thin layer of the liquid, and thin foils of scintillation material are enclosed within the vessel. The background of the apparatus is 2 impulses/min, and liquids of specific activity of 10^{-6} μC/ml can be measured with an error of ±12%. (D.L.C.)

33975 RADIATION MEASURING APPARATUS. Wolfram Frey and Karl-Heinz Oertel (to VEB Vakutronik). British Patent 966,388. Aug. 12, 1964. Filed Nov. 14, 1960.

A radiation detection instrument of the pulse type is designed which gives a more nearly linear calibration curve so that larger dosages may be measured. The instrument comprises a non-self-quenching counter tube, a working resistance in the form of a voltage divider in series with the tube, and an overloadable detection system. At low dose rates, the system records only a small part of the pulses from the tube, while at high dose rates the system records all the pulses because they have become smaller due to the non-self-quenching nature of the tube. (D.L.C.)

33976 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR DETECTING RADIOACTIVE PARTICLE EMISSION. Herbert Halsey (to Plessey Co. Ltd.). British Patent 966,746. Aug. 12, 1964. Filed Mar. 21, 1960.

A device is designed for detecting beta particles emitted from radioactive material on a movable member such as a wire on which fission products have been precipitated from a reactor coolant. The device comprises a phosphor shaped to embrace the movable member and coupled via a guide to

a photomultiplier tube. The guide is formed with a parabolic shape so that reflections are minimized. The device is located in the wall of a vessel containing the radioactive gas which is precipitated onto the movable member. (D.L.C.)

33977 MEANS FOR DETERMINING THE DIRECTION AND VELOCITY OF NUCLEAR PARTICLES. A. Roberts (to U. S. Atomic Energy Commission). U. S. Patent 3,140,394. July 7, 1964.

A technique for determining the velocity and direction of charged particles is described. The particles are directed into a Čerenkov detector; and resultant individual ring images are focused on an image intensifier, the size and position of the ring images corresponding respectively to the velocity and direction of the individual particles. Specific spectrally matched components are provided for recovery of very faint light falling in a narrow band of wavelengths and for accuracy and sensitivity. (AEC)

33978 NEUTRON DETECTOR UNIT UTILIZING INDIUM. H. F. Henry (to U. S. Atomic Energy Commission). U. S. Patent 3,140,397. July 7, 1964.

A technique for detecting and measuring fast neutron energy spectra under high dose rate conditions is described. An In body mounted within an In shield and a Cd shield serves the purpose of the ^{238}U fission foil of a conventional unit, and a Mn body mounted within an In shield and a Cd shield serves the purpose of the ^{238}Np and ^{239}Pu fission foils of the conventional unit. A combination of these units in a single detector unit consisting of a central In body surrounded by a Mn shell, an In shield, and a Cd shield can also be used. Use of a combined detector unit of shielded In and Mn in a personnel dosimeter badge is also described. (AEC)

33979 NEUTRON DOSIMETER UTILIZING A FISSION FOIL. P. W. Reinhardt and F. J. Davis (to U. S. Atomic Energy Commission). U. S. Patent 3,140,398. July 7, 1964.

A method for measuring and expressing fast neutron spectra directly in terms of dose is described, which involves in situ counting with a fission detector of the fission fragments from a composite foil. The foil comprises, for example, a Ni disk which may be electroplated with a mixture of ^{235}U, ^{237}Np, and ^{238}U. The detector may be a solid state surface barrier device. The detector and foil are enclosed within suitable thermal neutron shielding for eliminating thermal neutrons. The detector is connected to suitable instrumentation for providing a direct indication of the fast neutron spectrum in terms of dose. (AEC)

33980 SELECTOR FOR FAST AND INTERMEDIATE ENERGY NEUTRONS POSITIONED WITHIN MODERATOR AND ABSORBER SHIELDS. Leo H. Weinberg (to U. S. Atomic Energy Commission). U. S. Patent 3,141,092. July 14, 1964.

A neutron dosimeter is described in which one end of a BF_3 detector is enclosed within a moderator and neutron absorber, so that an increase in neutron energy has a greater effect at the detector in substantially the same proportion as the increasing energy increases the dosage. (AEC)

33981 THERMOLUMINESCENT DOSIMETER. Harold Heins, Cornelius J. Buckley, and Richard J. Broderick (to Metcom, Inc.). U. S. Patent 3,141,973. July 21, 1964. Filed Sept. 11, 1962.

An accurate, reliable thermoluminescent dosimeter is described in which the thermoluminescent and spurious triboluminescent effects are maximized and suppressed, respectively, by the phosphor mounting technique. Any thermoluminescent phosphor with a preponderance of deep electron traps and with chemical and physical stability at temperatures from ambient to several °C above the flow curve maximum temperature can be used. Methods of phosphor preparation and dosimeter construction are described. (D.C.W.)

33982 APPARATUS FOR MEASURING THE RADIOACTIVITY OF LIQUID SAMPLES. Joseph Fratantuno (to Lab. for Electronics, Inc.). U. S. Patent 3,141,977. July 21, 1964. Filed July 29, 1959.

An automatic apparatus for storing, handling, and counting a large number of liquid gamma samples is described. The detector volume is isolated from the gamma radiation of the storage volume, and a mechanism is provided for transferring samples from a storage position to a counting position within the core of a well counter. (D.C.W.)

ISOTOPE TECHNOLOGY

General

33983 (HW-SA-3080(Rev.)) THE FISSION PRODUCTS. C. A. Rohrmann (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 8, 1964. Contract AT(45-1)-1350. 17p. (CONF-635-1)

From AEC Atomic Industrial Forum, Washington, D. C., May 1964.

Radioisotopes as potential heat sources are discussed briefly. Of the usable radioisotopes, four are fission products: ^{144}Ce, ^{137}Cs, ^{147}Pm, and ^{90}Sr. The separation of these fission products from wastes at Hanford is discussed, and the results of an engineering study of the economics of such separation in the future are summarized. The processes for carrying out the separation and purification are described. Separation of other isotopes from power reactor fuel reprocessing is also considered. (D.L.C.)

33984 (TID-8540(p.477-528)) REACTOR BY-PRODUCTS. A. F. Rupp (Oak Ridge National Lab., Tenn.).

Some general characteristics and uses of fission products, neutron-produced radioisotopes from hydrogen to uranium, and transuranium isotopes are described. Processing and transportation are discussed. A bibliography of 81 references is presented. (R.E.U.)

33985 LIMITATIONS ON THE USE OF ISOTOPES IN REACTION MECHANISMS. PART II. SOLVOLYTIC AND OXIDATION REACTIONS. S. V. Anantakrishnan, P. S. Radhakrishnamurti, and H. Jayaraman (Madras Christian Coll., Tambaram, India). Current Sci. (India), 33: 361-2 (June 20, 1964).

The use of tracers in solvolytic and oxidation reactions is analyzed. The results showed that isotopic tracer techniques in these reactions give only very limited information and do not help in the choice of mechanism, particularly in oxidation reactions. Complications and problems that arise in oxidation and solvolytic reactions are discussed. (P.C.H.)

Industrial Applications

Refer also to abstract 33376.

33986 (AEC-tr-6399) RADIOISOTOPIC METHODS FOR AUTOMATIC CONTROL. REPORTS OF ALL-UNION CONFERENCE ON APPLICATIONS OF RADIOISOTOPES IN MEASURING TECHNIQUES AND INSTRUMENTS, JUNE 1961. VOLUME II. Translated from a publication of the Publishing House of the Academy of Sciences of the Kirgizskoi, SSR, Frunze, 1962. 296p.

Twenty-seven papers are presented on the various uses of radioisotopes and radiation in control of processes in industry. The papers treat such topics as radiometry, gamma-absorption analysis, neutron slowing-down, density measurement, level indication, photoeffect in CdS, automation, x-ray sources, etc. Separate abstracts were prepared for all of the papers. (D.L.C.)

For abstracts of individual papers see: 33466, 33467, 33468, 33469, 33470, 33471, 33472, 33473, 33843, 33844, 33845, 33846, 33847, 33848, 33849, 33850, 33851, 33852, 33853, 33854, 33885, 33987, 33988, 33989, 33990, 33991, and 34286.

33987 (AEC-tr-6399(p.202-6)) AUTOMATIC COORDINATION OF THE OPERATION OF MACHINES FOR THE DELIVERY OF COKE. I. A. Gridin, A. Z. Kulishenko, and A. S. Kharitonov. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 166-70(1962).

When coke is being unloaded from a furnace, it is necessary to coordinate the operation of the coke pusher, door-removing machine, and slaking wagon. An automatic coordination system was developed which uses gamma rays from ^{60}Co. The operation of the emitter and receiver is described, and the safety features of the system are outlined. (D.L.C.)

33988 (AEC-tr-6399(p.227-42)) AUTOMATIZATION OF THE CYCLE OF CRUSHING AND CLASSIFICATION OF ORES USING RADIOACTIVE ISOTOPES. M. Yu. Borukhov, A. T. Lebedev, and A. D. Kolodkevich. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 187-200(1962).

A new system using radioactive control methods was developed for the automatization of the two-stage cycle of crushing and classification of ores. The system automatically maintains the optimal charging of the crusher with ore and regulates the outflow density from the classifiers. The system underwent commercial tests. (D.L.C.)

33989 (AEC-tr-6399(p.243-57)) SOURCES OF X RAYS WITH STRONTIUM-90–YTTRIUM-90 AS A BASE. A. D. Tumul'kan, V. A. Yanushkovskii, N. A. Damburg, N. I. Bogdanov, and K. P. Zakharova. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 210-12(1962).

X radiation can be produced by excitation of various materials by beta particles from $^{90}Sr-^{90}Y$. An investigation was made of the effective yield and hardness of the x rays excited in this way. The possibility of preparing standard x-ray sources is studied, and several constructions are proposed for such sources. (D.L.C.)

33990 (AEC-tr-6399(p.258-76)) USE OF RADIOACTIVE INSTRUMENTS WITH RELAY ACTION IN SYSTEMS FOR AUTOMATIZATION OF TECHNOLOGICAL PROCESSES IN THE CHEMICAL INDUSTRY OF THE COUNCIL OF PEOPLES COMMISSARS, LATVIAN SSR. V. E. Banashek, D. Yu. Dekhtyar, V. P. Rogachev, V. N. Pozdnikov, and V. A. Yanushkovskiĭ. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 213-26(1962).

A description is presented of the experience gained in the development and introduction of radioactive automation of the relay type. The applications of such automation include: temperature regulation in fabrication of

plastic articles (phonograph records), preparation of multicomponent mixtures in perfume manufacture, liquid level control, automation of production of aluminum tubing, and automatic dispatching of articles on quality control line. (D.L.C.)

33991 (AEC-tr-6399(p.277-85)) POSSIBILITY OF AUTOMATICALLY SEPARATING POTATO TUBERS FROM LUMPS OF GROUND IN A POTATO HARVESTING MACHINE. V. P. Kaplin, V. N. Pozdnikov, N. I. Lapkovskaya, and S. A. Shabunin. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 227-34(1962).

An investigation was conducted on the use of soft gamma rays and x rays to differentiate between potatoes and rocks, clay, and loam. The results show that the soft gamma rays from ^{155}Eu should be useful in carrying out the separation, and that the separation should be carried out with an electromechanical separator of the relay type. A correction for the thickness of the absorbing layer is necessary. (D.L.C.)

33992 EFFECT OF VITAMIN K_3 AND TESTOSTERONE ON HEMORRHAGIC DIATHESIS IN RATS FED IRRADIATED BEEF. O. P. Malhotra, Elwood F. Reber, and Horace W. Norton (Univ. of Kansas, Kansas City). Am. J. Vet. Res., 25: 547-52(Mar. 1964).

Absorption of vitamin K in rats was analyzed by determining the relative effectiveness of oral vs subcutaneous administration of vitamin K_3, and the relation between vitamin K_3 and testosterone in the pathogenesis of hemorrhagic diathesis in intact and castrated male rats fed irradiated beef was investigated. The rats were fed a ration which contained ground nonirradiated or irradiated (5.58 MR) beef. Vitamin K_3 increased and testosterone decreased the prothrombin rate linearly. There was no interaction of the effects of the two substances. As shown earlier, the quantities of prothrombin and factor V are depressed in rats fed irradiated beef. Since prothrombin time is a function of prothrombin, factor V, factor VII, and factor X, the deficiency of one or more of these factors will prolong the prothrombin time or decrease the rate. Deficiency of prothrombin can be explained by the deficiency of vitamin K. (TCO)

33993 SOME EFFECTS OF GAMMA RADIATION ON THE STORAGE LIFE OF FRESH STRAWBERRIES. H. B. Heeney (Canada Dept. of Agriculture, Smithfield, Ont.), W. M. Rutherford, and K. F. MacQueen. Can. J. Plant Sci., 44: 188-94(Mar. 1964).

The effects of gamma radiation doses of 110,000, 220,000, and 330,000 rad on the storage life and quality of two varieties of strawberries stored at 40°, 55°, and 70°F were studied. Results indicated that a dose of 330,000 rad prevented fungal development of the Redcoat variety stored for 26 days at 40°F. The fungal-free period was sharply reduced at lower radiation doses or at higher storage temperatures. Under the conditions of this trial there was no apparent effect of radiation on appearance or texture of fruit. In organoleptic tests in the first two weeks of storage observers were not able to differentiate between radiation treatments. There was some preference for treated berries as the storage period increased. After 20 days the flavor of the fruit deteriorated very rapidly and it soon became commercially unacceptable. (auth)

33994 RADIOISOTOPES—HOW MUCH REGULATION NEEDED? J. C. F. MacDonald (Ontario Cancer Foundation, London). Can. Nucl. Technol., 3: 54-7(Summer 1964).

Radiation protection regulations in Canada and the way they affect the x-ray and radioisotope user are discussed. Topics covered include: choice of degree of risk, sensitivity variableness in living organisms, genetic hazards of radiation, medical exposures to radiation, insurance for radioisotope accidents, and ways of increasing the use of radioisotopes. (M.C.G.)

33995 CHARACTERISTICS OF A THERMAL NEUTRON BEAM FOR NEUTRON RADIOGRAPHY. H. Berger (Argonne National Lab., Ill.). Intern. J. Appl. Radiation Isotopes, 15: 407-14(July 1964).

A facility used for thermal neutron radiography is described. Neutron intensity, cadmium ratio, γ intensity, and beam angular divergence are discussed, and the influence of these beam properties on neutron radiographic results is indicated. The beam configuration most employed for radiographic applications provided a total beam intensity of 1.5×10^7 n/cm^2/sec, a cadmium ratio of 3.6 and a γ intensity of 42r hr over a useful beam coverage area of 2.5×4 in. Several areas in which this Juggernaut reactor beam facility was applied to radiographic problems are indicated. (auth)

33996 THE EFFECT OF FREEZING ON THE RADIATION SENSITIVITY OF BACTERIAL SPORES. A. Matsuyama, Margaret J. Thornley, and M. Ingram (Low Temperature Research Station, Cambridge, Eng.). J. Appl. Bacteriol., 27: 125-33(Apr. 1964).

As part of a study on food irradiation, the behavior of Clostridium perfringens and Bacillus pumilus were compared when irradiated at low temperatures with a ^{60}Co source at a dose rate of 224 kR/hr. Heat-shock applied before or after irradiation increased the number of survivors, and the proportionate increase varied with dose. In general, there was no difference in sensitivity of the two types of spores when irradiated at room temperature and at −79°. It is suggested that a combination of freezing, irradiation, and postirradiation heating produces some damage not caused by two of the processes. (TCO)

33997 THE POTENTIAL APPLICATION OF IONIZING RADIATIONS IN HYDROPONICS. A. M. Kuzin, T. S. Dubonosov, N. M. Berezina, R. R. Riza-Zade, and S. N. Tarkov (Inst. of Biological Physics, Moscow and Krasnodar Agricultural Scientific Research Inst., USSR). Radiobiologiya, 4: 457-9(1964). (In Russian)

In order to prepare green fodder by the hydroponic method, the grains are soaked in water for 8 hours and then are placed in wooden troughs where they are allowed to germinate for 10 days under suitable moisture conditions. From the 4th day on, mineral food is added. Previous studies indicated that γ irradiation of the grains before sowing accelerates the germination process and the development of the plants. The stimulating effect of the radiation was found to depend on the period between the exposure and the sowing. During 1963, the problem was investigated at a semi-industrial scale, exposing corn seeds to γ radiation at the Krasnodar Hydroponic Station. Bucovina-3 type hybrid corn seeds were irradiated by a specially built mobile source. The results indicated that γ irradiation under conditions used in hydroponics causes an increase in the yield of green material and an improvement of the quality. The results obtained warrant large-scale tests. (TTT)

33998 THE PROSPECTS OF MAKING USE OF THE RADIATION OF COBALT-60 FOR COMBATING THE GREY

ROT OF STRAWBERRIES. G. P. Solopov (All-Union Agricultural Correspondence Inst., Moscow). Radiobiologiya, 4: 460-2(1964). (In Russian)

Tests were made to establish whether γ irradiation is a satisfactory method for protecting strawberries against such attack by Botrytis cenerea, exposing a pure culture of the mold and strawberries infested by it to a 21,000 g-equivalent ^{60}Co source. It was found that only the total dose and not the rate, affects the growth of the mold. After exposure to 200 kR, the mold lost its ability to multiply. Calculations indicated a source with a dose rate of 400 R/sec, uniformly distributed on a surface of 1 m^2 is required. The econimic feasibility of the method depends on the original cost of the radiation source and on the possibility of taking advantage of it for the preservation of grains, fruits, and vegetables during other seasons. (TTT)

33999 VACUUM GAUGES USING RADIOACTIVE SOURCES EMITTING ALPHA RAYS OR BETA RAYS. BIBLIOGRAPHIC REVIEW. Rene Dagnac (Centre de Physique Nucleaire, Faculte des Sciences, Toulouse). Vide, 19: 135-40(May-June 1964). (In French)

A review is presented on the use of α and β emitting radioisotopes in vacuum gages. Different alphatron models are described, and their disadvantages are discussed. The use of beta sources without the same disadvantages are also discussed. (P.C.H.)

34000 ANALYSIS OF TOWER FLOODING WITH A SCINTILLATION COUNTER AND A CESIUM SOURCE. A. I. Snow and W. S. Dickinson (Sinclair Research, Inc., Harvey, Ill.). 12p. (CONF-488-8)

From American Institute of Chemical Engineers 53rd National Meeting, Pittsburgh, May 1964.

A radiometric level indicator was used for the analysis of flooding in a refining tower. The design of the indicator is given. The basic principle of the technique used is the fact that more electromagnetic radiation will be observed passing through material of low density than will be observed after passing through material of higher density. (P.C.H.)

Power Application

Refer also to abstracts 34499 and 35204.

34001 SPACE POWER SYSTEMS: STATE OF THE ART. George Szego (Inst. for Defense Analyses, Washington, D. C.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-525, 32p. $1.00. (CONF-600-7)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

A review is given of the development status and performance parameters of space power systems. The systems discussed include solar cells, SNAP-2, SNAP-8, SNAP-10A, SNAP-50, thermionic conversion fuel elements, chemical dynamic systems, radioisotope space power, SNAP-9, SNAP-9A, SNAP-11, SNAP-13, thermoelectric cells, MHD cells, fuel cells, and storage batteries. (C.E.S.)

34002 RADIOISOTOPIC SPACE POWER—PROSPECTS AND LIMITATIONS. C. A. Rohrmann and E. D. Sayre (General Electric Co., Richland, Wash.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-453, 9p. $1.00. (CONF-600-28)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The properties of ^{60}Co, ^{90}Sr, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{170}Tm, ^{204}Tl, ^{210}Po, ^{228}Th, ^{232}U, ^{238}Pu, ^{241}Am, ^{242}Cm, and ^{244}Cm are reviewed for use in radioisotope heat sources for direct conversion devices. (C.E.S.)

34003 POODLE—A DIRECT CYCLE RADIOISOTOPE-HEATED ROCKET ENGINE. J. S. Martinez and D. Jortner (TRW Space Technology Labs., Redondo Beach, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-383, 6p. $1.00. (CONF-600-35)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The POODLE rocket engine uses isotopic energy to heat hydrogen which is expelled through a conventional nozzle. The results of a survey are summarized, showing that ^{210}Po is the most promising isotope for this use, and engine design considerations are discussed. A hydrogen-fueled, POODLE-powered stage for use with Titan II is described, and payload characteristics of chemical-POODLE and all-chemical systems are compared. (D.C.W.)

Separation and Production

34004 (CEA-R-2337) SYSTÈMES DIFFÉRENTIELS DES FLUX ET DES CONCENTRATIONS D'UN MÉLANGE EN SÉPARATION PAR UNE USINE ÉTAGÉE. (Differential Systems of Flux and Concentrations of a Mixture in the Separation by a Plant Stage). Georges-Marie Bouligand (France. Comissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1964. 91p.

Thesis submitted to Université, Paris.

The study of transient flux and concentrations of a mixture in the separation by a plant with different interdependent stages leads to an examination of the solutions of certain types of differential systems. These systems are obtained from the representative graph of the plant and have a structural form. By Olga Taussky's theorem and the introduction of orientable distances, the solutions of these systems are chiefly examined in their asymptotic behavior. It is shown that solutions of partial differential equations relative to plants made of cascades with a slight separation have analogous properties. (auth)

34005 (ORNL-TM-879) ISOTOPES DEVELOPMENT CENTER, ISOTOPIC SEPARATIONS PROGRESS REPORT, JANUARY–MARCH 1964. L. O. Love, comp. (Oak Ridge National Lab., Tenn.). July 1964. Contract W-7405-eng-26. 22p.

The focusing of ions in the 255° calutron under two-arc operation was studied; source geometry and beam positioning factors are discussed. Separations of tungsten, sulfur, and magnesium isotopes are reported in progress. Calutron ion sources and receivers are discussed: an internally valved ion source feed system is described and its performance is shown for mercury, tungsten, and sulfur ions; a receiver (collector) specially for implanting impurities in single crystals is described and its performance is shown for ^{31}P deposition of p-type silicon. Sample contamination in the calutron is considered. A summary is given of current electromagnetic isotope separations for stable isotopes of Ba, Ca, Ni, Mg, S, Si, and W. Enriched isotope recovery for plutonium series "a" is reported; results are given for ^{239,240,241,242}Pu. Uranium-233 separation series are discussed; preliminary results are given. Electrodeposition of ^{241}Am, ^{237}Np, and ^{240}Pu is reported. A

mathematical study was made of the concentration gradients in a mixture of many isotopes at equilibrium in a thermal diffusion column. Neon-21, ^{38}Ar, ^{13}C, and ^{86}Kr concentrations in columns are reported. (R.E.U.)

34006 (ORNL-TM-889) ISOTOPES DIVISION QUARTERLY REPORT, JANUARY–MARCH 1960. J. H. Gillette (Oak Ridge National Lab., Tenn.). June 1964. Contract W-7405-eng-26. 41p.

Routine production of ^{14}C, ^{137}Cs, ^{60}Co, ^{131}I, ^{192}Ir, and ^{32}P is reported. Special samples of ^{131}I, ^{113}Sn, ^{55}Fe, ^{63}Ni, ^{125m}Te, ^{147}Pm, and ^{234}Th were prepared; methods are reviewed. Shutdown installation and maintenance of the Fission Products Pilot Plant are discussed. The macroscopic cross section for the reaction $^{147}Pm(n,\gamma')^{148}Pm$ was determined for both 5.2- and 42.0-day ^{148}Pm. Percent fission yields for neodymium isotopes were determined. Inorganic ion exchange materials were tested for ^{137}Cs removal from Savannah River waste, which contained sodium ions at 6M: Decalso (an aluminosilicate) was found to perform satisfactorily. Minerals were tested for their efficiency in removing ^{137}Cs, ^{90}Sr, and ^{106}Ru from dilute alkaline wastes prior to ground disposal. The removal of ruthenium tetraoxide from air by aqueous scrubbing is discussed. Pm-147 separation by solvent extraction, ^{99}Tc purification by solvent extraction, preparation of Tc-metal by H_2 reduction of the salt, preparation of strontium titanate by precipitation, and determination of ^{33}P in ORR-produced ^{32}P are discussed. Electromigration methods and results for ^{137}Cs separation are described. Developments and revisions in the F3P cells during shutdown are discussed. Calutron separations of indium, barium, lead, and chromium isotopes are described. High-purity-chemistry techniques are discussed. (R.E.U.)

34007 (ORNL-TM-890) ISOTOPES DIVISION QUARTERLY REPORT, JANUARY–MARCH 1961. J. H. Gillette (Oak Ridge National Lab., Tenn.). June 1964. Contract W-7405-eng-26. 37p.

Routine processing of ^{14}C, ^{137}Cs, ^{60}Co, ^{131}I, ^{192}Ir, ^{85}Kr, ^{32}P, and ^{99}Tc, and nonroutine processing of ^{14}C, ^{131}I, ^{125}I, ^{55}Fe, ^{204}Pb, ^{147}Pm, ^{90}Sr, ^{125m}Te, and ^{137}Cs are reported. The effect of sodium concentration on the batch separation of strontium and sodium was investigated for a typical strontium, calcium, and barium feed; iron extraction from the feed prior to strontium removal was studied. Foam separation process developments are discussed. Iodine-125 was produced from ^{124}Xe adsorbed on coconut charcoal. The separation of ^{147}Pm from ^{147}Sm by DTPA ion exchange is described. Conditions were established for electroplating plutonium on platinum. Uranium was electroplated on platinum and stainless steel. The properties of Decalso (an aluminosilicate cation exchanger) were studied as a component of leach-resistant glass radiation sources; leaching tests were run at room temperature on 0.1-mC sources of ^{137}Cs, ^{89}Sr, ^{204}Tl, and ^{144}Ce. Technetium chemistry is discussed. Some equipment modifications for the Fission Products Development Laboratory are described. The operation of a thermal diffusion column for ^{36}Ar, and the development for ^{21}Ne, ^{13}C, ^{85}Kr, and ^{124}Xe are reported. Calutron operations for the period covered are discussed: isotopes included are Ca, Ni, Dy, K, Yb, Zr, Cl, Mg, and Sn. (R.E.U.)

34008 (TID-3091(Suppl.1)) HEAVY WATER PRODUCTION. An Annotated Bibliography of Selected Literature. James M. Jacobs, comp. (Division of Technical Information Extension, AEC). June 1964. 45p.

Presented are 161 references to report and published literature on various methods for separating deuterium from the more abundant hydrogen isotope, covering the period 1959 through May 1964. Report number and availability, author, patent, and subject indexes are provided. (auth)

34009 ELECTROLYTIC SEPARATION OF LITHIUM ISOTOPES IN AQUEOUS SOLUTIONS OF LITHIUM HYDROXIDE USING A MERCURY CATHODE. Bengt Collén (Research Inst. of National Defence, Stockholm). Acta Chem. Scand., 18: 805-12(1964).

The separation factor, α, for lithium isotopes in the electrolysis of aqueous solutions of lithium hydroxide at a streaming mercury cathode was investigated as a function of temperature, current density, and electrolyte concentration. At 25°C a separation factor of 1.069 ± 0.004 was obtained in 5M LiOH at a current density of 0.25 A/cm^2. The separation factor and the difference in activation energy of the isotopes for the electrolytic process were found to be dependent of the studied parameters. (auth)

34010 THE SEPARATION OF URANIUM ISOTOPES IN THE FRENCH NUCLEAR PROGRAM. Pierre Couture (Commissariat à l'Energie Atomique, Saclay, France) and Robert Galley. Energie Nucl., 6: 129-34(May 1964). (In French)

Work done on the separation of ^{235}U in Pierrelatte, France is discussed. The advantages of enriched U over Pu as a nuclear fuel for specific applications are pointed out. (P.C.H.)

34011 EVALUATION OF ELUTION GAS CHROMATOGRAPHY AS A METHOD FOR THE PRE-ENRICHMENT OF TRITIUM FOR LOW-LEVEL COUNTING. J. L. Borowitz and J. R. Gat (Weizmann Inst. of Science, Rehovoth, Israel). Intern. J. Appl. Radiation Isotopes, 15: 401-6 (July 1964).

The conditions for attainment of high enrichment and complete recovery of trace amounts of HT in hydrogen gas by elution gas chromatography were determined. The applicability of this technique to high precision tritium preenrichment for low-level counting is discussed. Various experimental schemes for carrying out these separations are proposed and some of their advantages and shortcomings pointed out. (auth)

34012 NOMOGRAPHS FOR CALCULATING INDUCED RADIOACTIVITY AND DECAY. E. Ricci (Oak Ridge National Lab., Tenn.). Nucleonics, 22: 105-7(Aug. 1964).

Nomographs useful for activation analysis, flux monitoring, and radioisotope production that are capable of handling the wide range of conditions encountered with reactors, accelerators, and neutron generators are presented. Algebraic exponents of ten allow an infinite number of values to be entered for flux, current, cross section, reaction rate, and saturation activity. Any particle flux or charged-particle current can be entered in the scale provided that the definition of this flux or current is consistent with that used in the scale. (C.E.S.)

34013 SEPARATION FACTOR IN ISOTOPIC PHASE EQUILIBRIA. Giovanni Boato and Gualtiero Casanova (Università, Genoa). p.16-33 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The theory of the separation factor in isotopic phase equilibria of simple systems is presented and various approximations are discussed. Particular emphasis is given to the study of monatomic systems (argon and neon) which was carried out by the present authors and their

coworkers, both for solid-vapor and liquid-vapor equilibrium. The experimental methods are briefly reviewed and the theoretical results are discussed in light of the more recent experimental data. It is shown that many of the experimental results are explained or at least qualitatively understood. (auth)

34014 IMPROVEMENTS IN AND RELATING TO RADIOACTIVE CAESIUM. (to Nihon Genshiryoku Kenkyu Sho). British Patent 965,894. Aug. 6, 1964. Priority date Nov. 2, 1962, Japan.

A process is given for preparing ^{132}Cs of high radiochemical purity. The process is based on the $^{133}Cs(\gamma,n)$ reaction induced by high-energy bremsstrahlung (maximum energy >10 Mev) in a ^{133}Cs compound. Higher specific activity is obtained, and the ^{132}Cs may be produced on a mass scale. (D.L.C.)

MATHEMATICS AND COMPUTERS

34015 (HW-81117(Rev.1)) GANDS: A PROGRAM TO DERIVE WESTCOTT PARAMETERS FROM THE RBU BASIC LIBRARY. E. Z. Block (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 10, 1964. Contract AT(45-1)-1350. 9p.

The FORTRAN II program is used to extract Westcott g and s factors from the RBU tape; the program also fits the factors to polynomials in temperature for use in the MELEACER code and codes that use this form. GANDS is built upon the 1/E version of the program BARNS. The program is for a 32K IBM 7090. (R.E.U.)

34016 (JEN-122-DF/I-38) "SYRIO" — PROGRAMMA PARA EL CALCULO DE LA INVERSA DE UNA MATRIZ. ("SYRIO" — A Program for the Calculation of the Inverse of a Matrix). Luis Garcia de Viedma Alonso (Spain. Junta de Energia Nuclear, Madrid). 1963. 20p.

SYRIO is a code for the inversion of a nonsingular square matrix whose order is not higher than 40. The code is designed for the UNIVAC-UCT (SS-90). The procedure uses part of the Sherman and Morrison inversion formula and parallels Wilf's method for special matrices. It is generalized to any kind of nonsingular square matrix. The limitation of the matrix order is not inherent in the program itself, but is imposed by the storage capacity of the computer for which it was coded. (tr-auth)

34017 DATA PROCESSING AT THE EDF 3 CHINON NUCLEAR POWER PLANT. Ch. Grunberger and M. Morin. Energie Nucl., 6: 135-41(May 1964). (In French)

Data processing at EDF 3 will be, for the most part, similar to that at EDF 1 and EDF 2, but will differ by the fact that the data will be processed by a unique system that allows, in addition, even more complex calculations. The processing system, with a CAE 530 computer at its heart, is briefly described and the functions that it fulfills are more carefully developed: measurement processing (monitoring, statistics), information processing, automation and DRG processing, calculation, and control functions whose purpose is the optimization of the operation and its automation. The general arrangements adopted in order to insure the continuity of plant operation are indicated. (auth)

34018 DETERMINATION OF THE DIFFUSIVITY OF AN ISOTROPIC MEDIUM. J. R. Cannon, Jim Douglas, Jr., and B. Frank Jones, Jr. (Brookhaven National Lab., Upton, N. Y.). Intern. J. Eng. Sci., 1: 453-5(1963). (BNL-6811)

The determination of the diffusivity of an isotropic medium is reduced by the resolution of a simple linear differential equation of the elliptic type by the appropriate choice of conditions at the superspecificity limits. (tr-auth)

34019 INVERSION OF CYCLIC MATRICES. Jean-Louis Calais and Klaus Appel (Uppsala Univ.). J. Math. Phys. (N. Y.), 5: 1001-8(Aug. 1964).

The inversion of the overlap matrix in LCAO calculations of crystals is discussed for the general case, when an arbitrary number of neighbors is taken into account. Of the several alternative methods that are possible in one dimension, one is singled out — which can be used as well in three dimensions — to calculate the inverse to any desired accuracy. Particular attention is paid to the numerical aspects of the problem. (auth)

34020 UPPER AND LOWER BOUNDS ON GENERALIZED FOURIER COEFFICIENTS. L. M. Delves (Univ. of New South Wales, Kensington, Australia). J. Math. Phys. (N. Y.), 5: 1055-60(Aug. 1964).

Methods are given for obtaining variational upper and lower bounds on the nth Fourier coefficient $C_n^2 = |\int g^* \sigma U_n d\tau|^2$ of a function g relative to a sequence of eigenfunctions U_n. The methods differ in their ease of application and in the amount of information required concerning the eigenvalues associated with the U_n. Some illustrative examples are included. (auth)

34021 UPPER AND LOWER BOUNDS ON THE MATRIX ELEMENTS OF AN ARBITRARY BOUNDED OPERATOR. L. M. Delves (Univ. of New South Wales, Kensington, Australia). J. Math. Phys. (N. Y.), 5: 1061-4(Aug. 1964).

Methods are given for constructing variational upper and lower bounds on the matrix element $W_{mn} = \int U_m^* W U_n d\tau$ of an arbitrary bounded operator W between two eigenstates U_m and U_n of a Hamiltonian. Numerical examples of the method are given. (auth)

34022 ASYMPTOTIC EXPANSION OF CERTAIN INTEGRALS CONTAINING THE BESSEL FUNCTION $J_0(x)$. Paul W. Schmidt (Univ. of Missouri, Columbia). J. Math. Phys. (N. Y.), 5: 1183-?(Aug. 1964).

An asymptotic expansion is calculated for the integral $2/\pi \int_0^1 dx f(x) J_0(kx)/(1-x^2)^{1/2}$, where $J_0(x)$ is the zero-order Bessel function of the first kind, and the function f(x) and all its derivatives are continuous for $0 \leq x \leq 1$. To find the asymptotic expansion, the integral is converted to a Fourier integral, to which asymptotic expansion techniques are applied. The method can be generalized to apply to related integrals. (auth)

34023 ISOLATED EIGENVALUE OF A RANDOM MATRIX. Donald W. Lang (Bartol Research Foundation, Swarthmore, Penna.). Phys. Rev., 135: B1082-4(Aug. 24, 1964).

It is shown that there is always an eigenvalue of a random real symmetric matrix, the magnitude of which is ≥ the magnitude of the mean of the sums of the elements in a row of the matrix. The statistical conditions are established for such an eigenvalue to be isolated in magnitude. It is also shown that, statistically, the associated eigenvector of the isolated eigenvalue has most of its components near the mean component. (auth)

34024 ON THE DIFFERENTIAL EQUATIONS OF BRILLOUIN-WIGNER PERTURBATION THEORY. W. Byers Brown and William J. Meath (Univ. of Wisconsin, Madison). Proc. Natl. Acad. Sci. U. S., 52: 65-7(July 1964).

It is shown that the Brillouin-Wigner perturbation theory may be derived directly from the Schrödinger equation. A set of inhomogeneous differential equations is obtained. (M.C.G.)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstract 35064.

34025 (AD-428036) PROCESS IMPROVEMENT OF COLUMBIUM (Cb-752) ALLOY. Phase I Interim Engineering Progress Report, July 1, 1963–November 30, 1963. M. Schussler and J. G. Bewley (Union Carbide Corp. Stellite Div., Kokomo, Ind.). Contract AF33(657)-11210. 80p.

In order to meet established objectives of improved tensile properties and, most important, increased thickness control, improved flatness, and surface finish of the niobium (Cb-752) alloy sheet, a number of processing routes and final annealing temperatures were investigated. A total of 112 pounds of Cb-752, $\frac{1}{4}$-in. sheet bar was processed to 0.030-, 0.018-, 0.012-, and 0.008-in. thick sheet by ten different reduction-annealing schedules. Rolling variables were investigated in an attempt to obtain improved thickness uniformity and flatness. The sheet produced was measured for flatness, thickness uniformity, and surface finish to evaluate the effect of the processing variables on these properties. (auth)

34026 (AD-428771) INVESTIGATIONS CONCERNING Y–Mn AND Gd–Mn ALLOYS PREPARED BY THE AMALGAM PROCESS. Technical Note No. 6. F. Lihl (Vienna. Technische Hochschule). Oct. 31, 1963. Contract 61(052)-609. 27p.

By continuing the efforts to refine all methods, for which many improvements have been necessary, the whole amalgam process has been developed to a safe, reliable method. The Y–Mn system was chosen to test the whole procedure. Approximately 40 alloys with 7 different concentrations (20 to 90 wt % Mn) were prepared. The alloys consist of powders, which are free of contaminations and are in an equilibrium. The compounds YMn2 and YMn4 have been studied intensively. YMn2 is cubic, the lattice spacing ($a = 7{,}692(5) \pm 0.001$ Å) was determined with far better accuracy than has been done up to now. (auth)

34027 (AD-428772) INVESTIGATIONS OF RARE EARTH–MANGANESE ALLOYS (0–25% Mn). Technical Note No. 5. F. Lihl (Vienna. Technische Hochschule). July 31, 1963. Contract 61(052)-609. 27p.

The preparation of rare earth (RE)–Mn–amalgams, evaporation of mercury, preparation of mercury-free alloys, and the examination of the alloys by metallographic and x-ray methods are described. Preparation of the RE (Y, Sm)–Mn–amalgams was simplified by developing a special method. Manganese metal, if pretreated in the right manner, can be dissolved simultaneously with the RE-metal in mercury, yielding directly the RE–Mn–amalgam (RE + Mn = approx. 1 wt %). By this method pure amalgams, not contaminated by oxygen, can be produced in a reasonable time. (auth)

34028 (AD-430037) THE PREPARATION OF RARE EARTH–MANGANESE–MERCURY ALLOYS. Technical Note No. 3. F. Lihl (Vienna. Technische Hochschule). Jan. 31, 1963. Contract 61(052)-609. 25p.

A method is described which allows by means of mercury to prepare RE–manganese alloys, which are in an equilibrium state at 300 to 500°C. The process consists of 4 steps, namely (1) preparation of RE–amalgams by dissolving the metal in mercury at 450°C, (2) preparation of manganese–amalgam by electrolysis, (3) reaction between RE–metal, manganese, and mercury, and (4) evaporation of the mercury. The process has been used for the preparation of samarium– or gadolinium–manganese alloys, but it is applicable to all Re–metals and numerous other metals besides manganese. (auth)

34029 (AD-601740) STUDY OF DUCTILE COATINGS FOR THE OXIDATION PROTECTION OF COLUMBIUM AND MOLYBDENUM ALLOYS. Bimonthly Progress Report No. 5, March 1–April 30, 1964. (Metals and Controls Inc., Attleboro, Mass.). May 31, 1964. Contract NOw 63-0706-c. 32p.

Air flow versus weight loss rate data on pure platinum is extended to an air flow rate of 960 ipm at 2550°F. Increases in flow rate are seen to have a diminishing effect on weight loss rates at higher and higher flow rates. Diffusion studies were performed on platinum–2.5% palladium alloy clad FS-85 and TZM at 2550°F. The diffusion appeared to be transgranular and very rapid for both the TZM and the FS-85 base samples. Layers of gold, rhenium, aluminum, and boron nitride were deposited on refractory base metal for diffusion barrier studies. Evaluations of the samples containing aluminum and boron nitride have initially indicated that these materials will not be useful for diffusion barriers. (auth)

34030 (APL-TDR-64-73) SPUR POWER SYSTEM TOPICAL REPORT ON BIAXIAL CREEP OF MATERIALS IN LITHIUM: DEVELOPMENT OF APPARATUS AND TRIAL RUN WITH TYPE 304L STAINLESS STEEL. For Period Ending April 1964. (Aerojet-General Nucleonics, San Ramon, Calif.). Apr. 24, 1964. For Garrett Corp. AiResearch Mfg. Div. of Arizona, Phoenix. Contract AF33(657)-8954. 85p. (SY-5472-R)

Specific biaxial stress in a cylindrical capsule can be achieved by controlling capsule wall thickness and pressure inside the capsule. Since creep is limited to a thin wall section of the capsule, several stresses can exist simultaneously in the same capsule if sections of the capsule wall are machined to different thicknesses. As creep occurs, the diameters of the thin sections increase, while the length of the capsule does not change significantly. Creep specimens of the materials to be tested under this program were made by fabricating cylindrical capsules designed to be filled with pressurized lithium. An apparatus to measure the biaxial creep of alloys in contact with lithium up to 2500°F was constructed and successfully demonstrated. The creep apparatus consists of a high-vacuum tube furnace with a uniform temperature zone and auxiliary argon pressure systems, and is capable of holding four capsules. Strain is measured by stopping the test periodically and measuring the diameters of the thin sections of the capsule. A trial run in argon was completed with a two-stress, Type 304L stainless-steel capsule filled with lithium. With effective mean stresses of 2920 and 4645 psi, the effective strain measured after 1, 2.5, 5, and 11 hours was nearly linear and could be described by the equation $\dot{\bar{\epsilon}} = 4.2 \times 10^{-2}\, \sigma^{4.9}$. No effect due to the lithium exposure was apparent. Runs with Cb + 1 wt % Zr and B-66 alloys at 2200°F were planned, but funding limitations ended the task after the capsule parts for two- and four-stress capsules were fabricated. (auth)

34031 (BM-RI-6489) ELECTROREFINING BERYLLIUM. Operation of a Prototype Cell. Morton Min Wong and J. E. Klosterman (Bureau of Mines. Boulder City Metallurgy Research Lab., Nev.). Nov. 1963. 19p.

Scrap beryllium chips (nominally 96 to 97 percent Be) were electrorefined in a prototype cell with 408 lb of electrolyte composed of 52.4 mole-percent LiCl, 36.3 mole-percent KCl, and 11.3 mole-percent $BeCl_2$. The cell temperature was 500°C. In a typical $10^3/_4$-hour deposition cycle, 0.415 pound of metal was produced; the metal contained impurities in parts per million as follows: C, 700; O, 610; Al, 34; Ca, 32; Cu, 20; Fe, 25; Mg, 9; and Mn, 23. Operation of the prototype cell for 2 years demonstrated that adapting the electrorefining process to an enlarged scale of operation presented few difficulties in mechanical functions, maintenance of optimum operating conditions, and control of product purity. After the spent anode feed was leached in a 5-percent nitric acid solution and the fine-sized particles were removed, it was recycled in some tests. The metal produced was somewhat higher in impurities than metal from the fresh scrap chips. (auth)

34032 (BMI-1668(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING MARCH 1964. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1964. Contract W-7405-eng-92. 62p.

Progress is reported on reactor materials and components, fuel development, radioinduced formation of organotin compounds, coated-particle fuel development, corrosion studies in fluoride volatility process, creep-rupture of SAP alloys, mechanical properties of Zr alloys, fission product deposition, encapsulation studies, examination of irradiated Hastelloy X, and joining or regenerative cell components. (D.L.C.)

34033 (BMI-1669(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING APRIL 1964. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). May 1, 1964. Contract W-7405-eng-92. 59p.

Progress is reported on reactor materials and components, fuel development, radioinduced formation of organotin compounds, coated-particle fuels, corrosion studies in the fluoride volatility process, creep-rupture of SAP alloys, mechanical properties of Zr alloys, fission-product deposition, and irradiation of Hastelloy X and type 347 stainless steel. (D.L.C.)

34034 (BMI-1672(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING MAY 1964. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). June 1, 1964. Contract W-7405-eng-92. 47p.

Progress is reported on: reactor materials and components, fuel development, solid-state pressure bonding, radioinduced formation of organotin compounds, coated-particle fuels, corrosion studies in fluoride volatility process, creep-rupture of SAP alloys, mechanical properties of Zr alloys, fission-product deposition, irradiation of Hastelloy X and type 347 stainless steel, and development of small radioisotope power sources. (D.L.C.)

34035 (BMI-X-10053) DEVELOPMENT OF URANIUM MONONITRIDE. Quarterly Progress Report, April–June 1963. Donald L. Keller (Battelle Memorial Inst., Columbus, Ohio). July 1, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 23p. (EURAEC-795)

Powder-metallurgy and melting techniques have been developed for preparing dense UN bodies. Fabrication studies revealed that the second phase often found in UN bodies made from powder is likely in solution at fabrication temperatures and precipitates during cooling. Sintering studies in a nitrogen atmosphere produced little densification at temperatures up to 2250°C with three different types of UN powder. Both polycrystalline and single-crystal UN bodies were prepared by consumably melting uranium in a nitrogen atmosphere. Grain separation observed in polycrystalline material was nearly eliminated by isostatic hot pressing at 1500°C after melting. The solubility of UN in liquid uranium was determined at temperatures between 1350 and 2400°C at 1 atm of nitrogen. On the basis of results to date in the uranium–nitrogen phase studies, a tentative uranium–nitrogen pressure-temperature diagram has been constructed. Experiments to study constitutional changes in UN when heated in a thermal gradient have been under way. Equipment difficulties prevented thermal gradients more severe than about 130°C per cm or heat treatments beyond 11 days. Initial compatibility studies of UN with aluminum, zirconium, and stainless steel were carried out over a range of temperatures. Reactions were observed in all cases but to a significantly varying extent. Corrosion of UN, both cast and powder-metallurgy specimens, was measured in pure oxygen. The cast material showed a linear weight gain with time at 300, 400, and 450°C. The UN prepared by powder metallurgy showed a much accelerated attack at 300°C. (auth)

34036 (CEA-Bib-16) INFLUENCE DES RADIATIONS SUR LA CORROSION. (Influence of Radiations on Corrosion). Marie-Genevieve Vallee (France. Commissariat a l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). July 1964. 54p.

This bibliography of 213 references deals with the papers published to December 1962 inclusive on the effect of irradiation in a nuclear reactor on the corrosion of structural materials. The abstracts of the papers are included. (auth)

34037 (DMIC-Memo-192) SUMMARY OF THE EIGHTH MEETING OF THE REFRACTORY COMPOSITES WORKING GROUP. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Apr. 20, 1964. 20p.

A summary is presented of information on refractory materials and composites as presented at the Eighth Meeting of the Refractory Composites Working Group in Fort Worth, Texas, January 14–16, 1964. The summary is based on 45 papers covering a wide variety of subjects ranging from basic studies on oxidation mechanisms to the development of specific pieces of hardware. The papers are reviewed and discussed briefly within the framework of the following four broad areas: materials technology, process technology, specific hardware applications, and evaluation techniques. Included in the section on materials technology are discussions dealing with bulk refractory materials and coated-metal systems. Hot spraying, chemical vapor deposition, powder processes, joining, and extrusion are discussed in the section on process technology. The specific hardware applications cover rocket-motor components, nose caps, leading edges, hot skins, and fasteners. (auth)

34038 (EUR-1833.e) SOME OBSERVATIONS ON ANNEALED AND ION BOMBARDED SAP FOILS. E. Ruedl and Erika Staroste (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 22p. (CONF-425-4)

From Conference on Nonfissile Metals for Nuclear Reactors, Bologna, Dec. 1963.

Thin foils of an Al/4% Al_2O_3 SAP alloy, prepared by rolling, were investigated by means of electron diffraction and transmission microscopy. Both annealed and ion bombarded foils were examined. The annealed foils showed plate-shaped particles of varying size distributed in the matrix. The plates were probably monocrystals of cubic alumina and generally had their {111} flat face in contact with {100} aluminum matrix planes. No impurity precipitates could be detected. The plates could be imaged either by "structure factor" contrast or strain contrast. In the first case it was possible to measure the size and the spacing of the plates, while in the second estimates of the magnitude and sign of the strain associated with the plates could be made. The plates were found to be "interstitial", with ϵ, the strain parameter, equal to $|0.011 \pm 0.004|$. Moving dislocations were either stopped by the plates or passed midway by cross-slip. 30-kev H^+ and He^+ ions produced damage in the form of a dense dislocation tangle. On annealing at about 400°C; gas bubbles were formed, which behaved differently depending on whether they were filled with hydrogen or helium. The dislocations annealed out only near the melting point, presumably as a consequence of strong pinning by the alumina. (auth)

34039 (GA-5340) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Quarterly Progress Report for the Period Ending January 31, 1964. R. H. Chambers and T. A. Trozera (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. 9p.

The preparation and properties of tungsten crystals are discussed. From room temperature tensile tests, it is shown that the bcc crystals exhibit a flat load-extension curve, which is characteristic of easy glide. The propagation of a moving crack in the fracture of a brittle material is studied. Internal friction peaks are evaluated in plastically deformed bcc niobium. The mechanisms of various types of dislocations in crystals are studied. (N.W.R.)

34040 (GEMP-36A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 36, PART A. (General Electric Co. Advanced Technology Services, Cincinnati). June 19, 1964. Contract AT(40-1)-2847. 38p.

Study of BeO specimens irradiated in low-flux, low-temperature exposures provided information leading to a relatively complete understanding of the flux and temperature dependence of irradiation expansion. The mechanism appears to be a first-order process involving radiation-enhanced diffusion with modifications stemming from the presence of defect clusters. At temperatures above approximately 600°C, the expansion is dependent on the neutron flux and follows the equations cited in previous reports. At temperatures below 550 to 600°C, the mobility of the defects is such that the expansion over the dosage range of practical interest is essentially independent of the flux. Work was continued on the dissolution of ^{85}Kr in arc-cast Ta cathodes under self-sustaining glow discharge conditions. The attenuation of the beta emission from this isotope in Ta was evaluated and the construction of equipment to be used in fore-diffusion studies was begun. A small evacuated can made of arc-cast Ta was heated in an atmosphere of Kr containing ^{85}Kr for 1 hour each at 1730, 1950, 2140, 2340, 2450, and 2530°C, and an additional 36 hours at 2400°C without detection of any uptake of ^{85}Kr by the sample. Coprecipitated F-227 fuel ($UO_2-ThO_2-Y_2O_3$ with a mole ratio of 1:1:0.55) developed a single-phase, well-crystallized structure when reacted for 4 to 10 hours at 1900°C or 0.5 hour at 2200°C in Ar. The BeO fuel elements fueled with $UO_2-ThO_2-Y_2O_3$ compositions show little or no UO_2 loss (based on weight change) in 1000-hour fuel retention tests at 1300 and 1400°C in air. No detrimental changes in density, grain size, or strength occurred in the test specimens. The modulus of rupture of the BeO fuel elements increases with increasing temperature to a maximum near 1000°C. Measurements of linear thermal expansion and compressive creep of BeO elements fueled with $UO_2-ThO_2-Y_2O_3$ compositions up to 11.5 vol % fuel phase show that expansion and deformation are dependent on the major phase, BeO. (auth)

34041 (HW-80752) HIGH TEMPERATURE RADIATION DAMAGE TO GRAPHITE. PART I. PREPARATION OF GRAPHITES FOR IRRADIATION. J. T. Meers and J. F. Doar (Union Carbide Corp. Carbon Products Div. Research Lab., Parma, Ohio). Apr. 15, 1964. For General Electric Co., Hanford Atomic Products Operation, Richland, Wash. Contract AT(45-1)-1603. 68p.

The graphites selected and prepared for irradiation tests are described and the method of sample preparation is discussed. All preirradiation test data are tabulated by sample set. This includes purity, electrical and thermal conductivity, coefficient of thermal expansion, lattice spacings, density, and the sonic moduli. (auth)

34042 (MAB-199-M(1)) FIRST PROGRESS REPORT BY THE COMMITTEE ON BERYLLIUM METALLURGY OF THE MATERIALS ADVISORY BOARD. (National Research Council. Materials Advisory Board). June 16, 1964. 50p.

The most significant information derived from this meeting is summarized in the descriptions of current research and development projects of various organizations. Also itemized are the tasks of the subcommittees. Engineering properties and related characteristics of beryllium used in aerospace structural applications are summarized. (auth)

34043 (ML-TDR-64-173(Pt.I)) HIGH TEMPERATURE PROTECTIVE COATINGS FOR GRAPHITE. J. M. Criscione, R. A. Mercuri, E. P. Schram, A. W. Smith, and H. F. Volk (Union Carbide Corp. Carbon Products Div., Parma, Ohio). June 1964. Contract AF33(657)-11253. 87p.

A review of previous work on protective coatings for graphite, a description of several basic factors controlling the oxidation protection of graphite, and a review of existing information on the diffusion of oxygen and carbon through coating materials, the volatility, the chemical stability, and the mechanical compatibility of coating materials are presented. It is concluded that a considerable amount of research is needed to evaluate coating materials for the protection of graphite from oxidation at temperatures of 2000°C and higher. (auth)

34044 (NAA-SR-9600) NONDESTRUCTIVE DETERMINATION OF URANIUM-235 CONTENT OF SNAP FUEL RODS. VOLUME II. STATISTICAL METHODS FOR EVALUATING DATA OBTAINED FROM COUNTING EXPERIMENTS. M. A. Greenfield, C. T. Nelson and R. L. Koontz (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1964. Contract AT(11-1)-Gen-8. 23p.

A statistical method is given for evaluating the homogeneity of ^{235}U in reactor fuel rods on the basis of measuring the characteristic radiation of ^{235}U. Tests are given for detecting instrument fluctuations. Results are tabulated

for SNAP fuel rods; they show that the ^{235}U content can be determined for each rod to within 0.1%. (D.L.C.)

34045 (NAA-SR-9673) FISSION PRODUCT RELEASE FROM IRRADIATED URANIUM–ZIRCONIUM HYDRIDE SNAP FUEL. W. M. Cegelski (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1964. Contract AT(11-1)-Gen-8. 37p.

A series of experiments was performed to determine the fission product release from SNAP 10A/2 uranium-zirconium hydride fuel samples at temperatures of 2000 to 3500°F maintained for periods of one minute to 8 hours. (auth)

34046 (NASA-CR-54041) RESEARCH AND DEVELOPMENT PROGRAM ON MAGNETIC, ELECTRICAL CONDUCTOR, ELECTRICAL INSULATION, AND BORE SEAL MATERIALS. Second Quarterly Report, December 1, 1963–February 29, 1964. Report No. 64.14E. P. E. Kueser, et al. (Westinghouse Electric Corp., Lima, Ohio). Mar. 1964. Contract NAS3-4162. 166p. (N64-22244)

Design information on materials for application to advanced space electric power systems is evaluated. The test program, the specimen geometry, the test atmospheres, and the testing procedures are outlined. Mechanical tests were initiated on magnetic materials. Cube-textured materials have shown a variation in Poisson's ratio depending upon the orientation of the measurement in respect to the crystal lattice. A number of organic and inorganic insulation materials are presented including most configurations suitable for electric apparatus. A new conductor, beryllia dispersion-strengthened copper, is fabricated. It exhibits stress-rupture properties a factor of four better than beryllium–copper No. 10 at elevated temperature. Beryllium–copper is presently one of the better high-strength, high-conductivity materials available. The bore seal effort is focused on the development of metalized ceramic-to-metal sealing systems prior to their planned alkali-metal exposure tests. (auth)

34047 (NLCO-910) STANDARDS FOR METALLOGRAPHIC EVALUATIONS OF URANIUM METAL. M. H. Cornett (National Lead Co. of Ohio, Cincinnati). May 14, 1964. Contract AT(30-1)-1156. 8p. (CONF-619-1)

From 18th Meeting of the AEC Metallography Group, Los Angeles, June 1964.

Visual standards are presented for rating the degree of recrystallization of formed uranium metal, the inclusion content of as-cast uranium metal, and the inclusion and stringer content of formed uranium metal. (auth)

34048 (NP-14124) ETUDE DU PROCEDE DE FRITTAGE DU DIOXYDE D'URANIUM D'APRES LA THEORIE DE PINES. (Study of a Sintering Process for Uranium Dioxide According to the Pines Theory). M. M. Ristić and E. Kostić (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). June 1963. 12p.

The modifications in the characteristic properties of uranium dioxide were studied during sintering under an argon atmosphere. The results were interpreted from the viewpoint of the Pines theory. The diffusion coefficients for vacancies were determined from the change in the density of the samples as a function of the duration and temperature of sintering. The activation energy of 20.2 kcal/mol was determined from these results. (tr-auth)

34049 (NUMEC-P-106) DEVELOPMENT OF PLUTONIUM-BEARING FUEL MATERIALS. Progress Report, July 1–September 30, 1963. (Nuclear Materials and Equipment Corp., Apollo, Penna.). Contract AT(30-1)-2389. 46p.

Three lots of PuO_2 were prepared, and these materials will be mechanically blended with UO_2 to provide UO_2–PuO_2 fuels. In addition, UO_2–PuO_2 compositions were prepared by coprecipitation. All materials, except the UO_2–50 wt % PuO_2, composition sintered to greater than 92% of theoretical density. Since poor sinterability appears to be related primarily to impurity pickup, the investigation of the effect of controlled SiO_2 additions to coprecipitated UO_2–PuO_2 powder was continued. The results show that there is a significant reduction in sintered density over the range of SiO_2 concentration, 0 to 500 ppm; above this concentration the density is consistently low but does not decrease appreciably with increased impurity content. Oxidation and reduction studies were initiated using a variety of furnace atmospheres, temperature and time conditions, and heat-up and cool-down cycles. The results to date are quite erratic due to complicated interaction of many effects; even the heat-up and cool-down conditions have definite influence. The oxidation kinetics of UO_2–PuO_2 powders and pellets are also being assessed using thermogravimetric methods. From these data, oxygen diffusion coefficients are being determined, and the variation of these coefficients with Pu/U ratio is being ascertained. Data were generated for pellets over the composition range UO_2–0 wt % PuO_2 to UO_2–35 wt % PuO_2 and for powders containing 0.5 and 5 wt % PuO_2. The effect of controlled SrO additions on the sinterability of PuO_2 was investigated. The data indicate that sinterability is improved with addition of less than 1 mole percent SrO_2. Detailed design of the high burnup irradiation capsules was completed. (auth)

34050 (ORNL-3626(p.59-164)) MATERIALS STUDIES. (Oak Ridge National Lab., Tenn.).

Studies are presented of: evaluation of INOR-8 and various graphites for use in molten salt reactors; manufacture of MSRE control rod elements; radiation chemistry studies applicable to MSRE; and phase, solubility, crystallization, and stability studies on fluoride and chloride salt mixtures. (T.F.H.)

34051 (ORNL-TM-749) VACUUM DISTILLATION OF MAGNESIUM METAL. W. D. Box (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 6p.

A procedure was developed for producing up to 5-g quantities of ^{24}Mg, ^{25}Mg, and ^{26}Mg metal by simultaneous vacuum reduction and distillation of an MgO–Al mixture. Hot rolling is used to convert the crystalline product to foil form. (auth)

34052 (RTD-TDR-63-4063) DEVELOPMENT OF PRACTICAL TECHNIQUES FOR APPLYING PROTECTIVE COATINGS TO COLUMBIUM ALLOYS. J. Zupan, P. J. Chao, J. B. Whitney, and D. H. DeClerck (Pfaudler Co., Rochester, N. Y.). July 1963. Contract AF33(657)-8920. 69p.

Three coating processes—fused salt bath, fluidized bed, and slurry dip application—were investigated to develop practical and reliable techniques for applying oxidation protection coatings to niobium alloys. The substrate used was D-14 (Nb–5 Zr). Only coatings of known composition were applied. Titanium, chromium, and silicide coatings were deposited by the fused salt bath process; silicide coatings by the fluidized bed; and tin and aluminum coatings by slurry application. Early in the program, the work on slurries was expanded to include a study of their electrokinetic behavior. The several process variables perti-

nent to each technique were evaluated to determine the range of operating conditions that can be used to produce the desired coating. All coatings were tested for oxidation resistance at 2500 to 3000°F. Further evaluation included metallographic examination of the coated samples. The program resulted in the development of several suitable coatings. Work is being continued to demonstrate further the feasibility of these coating techniques. (auth)

34053 (TID-20862) METALLURGICAL STUDIES OF ZIRCONIUM AND THORIUM AND OF THE ALLOYING BEHAVIOR OF RARE EARTH-TRANSITION METAL SYSTEMS. Annual Progress Report, August 1, 1963–July 31, 1964. W. R. Clough (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-1)-2159. 9p.

The effects of rare earths on the mechanical properties, oxidation properties, and crystal structure of zirconium and on the crystal structure and phase studies of thorium are discussed. (N.W.R.)

34054 (UCRL-7795) SILICON NITRIDE AS A HIGH-TEMPERATURE RADOME MATERIAL. William M. Wells (California. Univ., Livermore. Lawrence Radiation Lab.). May 19, 1964. Contract W-7405-eng-48. (CONF-633-1)

From Electromagnetic Window Symposium, Columbus, Ohio, June 1964.

Silicon nitride was investigated fairly thoroughly for application as structural elements in high-temperature, air-cooled reactors. Measurements show that it can easily have values for the two common thermal stress parameters which are substantially higher than those for either alumina or beryllia. In addition, its long-time high-temperature strength (to at least 2700°F) is substantially better than either of these two oxides. Its oxidation resistance is very good. Most of its exceptional thermal stress resistance can be attributed to its low modulus of elasticity and low coefficient of thermal expansion. Actual experience with purchase of the same shape made from both alumina and silicon nitride show that the nitride is the cheaper. Of the properties of silicon nitride which are significant in radome applications, the electrical properties are least known. However, the one available published value of dielectric constant (9.4) seems reasonable. (auth)

34055 (UCRL-11043) SOLUBILITY OF HELIUM IN URANIUM DIOXIDE (thesis). Firooz Rufeh (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). Mar. 19, 1964. Contract W-7405-eng-48. 57p.

Solubility of helium in uranium dioxide powder at 1200 and 1300°C was found to be 6.71×10^{-4} and 3.23×10^{-4} cc(STP)/g-atm, respectively. From a plot of helium concentration as a function of time, a diffusion coefficient at 1200°C was estimated to be 1.5×10^{-13} cm^2/sec. It was also shown that the He–UO_2 system obeys Henry's law. A high-pressure furnace that operates at 2000°C in the pressure range of 100 atm to 10^{-5} torr was designed and constructed to saturate UO_2 powder of 4-μ average particle size with He^4. The powder was then dissolved in a fused salt in an induction chamber. The released He^4 was mixed with a known quantity of He^3 and the mixture was analyzed with a mass spectrometer to determine the He^4–He^3 ratio, hence the original mass of He^4 in the sample. (auth)

34056 (UCRL-11355) EFFECT OF STRESS ON PERMEATION THROUGH ALUMINA MEMBRANES (thesis). Amin Edwards Atallah (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1, 1964. Contract W-7405-eng-48. 31p.

The effect of biaxial tensile stress on gas permeation through normally impermeable alumina membranes was investigated at room temperature. Tests were conducted at various loading cycles on two groups of alumina bodies. Group A had a membrane thickness ranging between 700 and 1000 microns. Group B had a membrane thickness of approximately 125 microns. The load and the length of time of load application were independently varied. No permeation could be detected through the thick alumina membranes. Thin membranes showed no permeation under low loads; leakage through the sealing cement prevented detection of permeation through these membranes at high loads. Heating in air was found to heal microcracks induced by diamond-grinding the thin alumina membranes. It is proposed that vacuum heating to reactivate membranes which previously exhibited permeation had also healed previously induced microcracks. (auth)

34057 (UCRL-11411) THE ELECTROMAGNETIC LEVITATION OF METALS. Peter R. Rony (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). May 7, 1964. Contract W-7405-eng-48. 94p. (CONF-603-5)

From Transaction of Meeting, Vacuum Metallurgy American Vacuum Society, New York, June-July 1964.

A variety of subjects connected with the electromagnetic levitation of metals is considered. A complete theoretical description of the phenomenon is given, leading to the basic equations for the lifting force and power input for a metal sphere levitated in an inhomogeneous sinusoidally alternating magnetic field, $\vec{F}/W = [3\ G(x)/2\ \rho\mu_0]\ (\vec{B} \cdot \nabla)\vec{B}$; $P = [3\pi R\ H(x)/\sigma\ \mu_0^2]\ (\vec{B} \cdot \vec{B})$; where $x = R\ [(1/2)\omega\mu\sigma]^{1/2}$, ρ, σ, μ, and R are the metal density, electrical conductivity, permeability, and radius, respectively, B is the magnetic-field strength, ∇ is the vector del operator, and ω is the radian frequency of the magnetic field. Both the force and power cannot be simultaneously controlled with the current-control knob of an induction heater. The suspended metal is suitably controlled either by operating at lower frequencies and supplying additional heat with an electron beam, plasma-arc torch, high-frequency induction heater, or reflection furnace, or by operating at high frequencies and employing high-thermal-conductivity gases such as hydrogen and helium to cool the metal. Values indicating the ease of levitation of 1-cm-radius spheres of more than 50 different metals at 0°C and at their respective melting points are given. When frequencies in the 10 to 100 kc/sec range are used, the density of the metal chiefly determines the ease of levitation. Refractory, semiconducting, or dielectric materials can be levitated either by heating them to high temperatures to decrease their electrical resistivity or by coating a light and inert metal of high melting point with the material to be studied. Liquid sodium surrounded by a mineral oil of almost identical density can be used to study the magnetic-field distribution of levitation coils. Liquid mercury can be used to determine the ability of levitation coils to suspend high-temperature liquid metals. Although the use of this technique with large commercial quantities of liquid metals appears discouraging, the levitation of long rods or plane sheets of liquid metals does appear to be feasible, provided that these configurations are not dynamically unstable. More attention should be given to the improvement of commercial levitation equipment through the use of variable frequencies, solid-state circuits, and high-permeability magnetic core materials with low losses. The ideal levitation power supply would have a variable frequency for the range of 500 cps to 50 kc/sec, a decade capacitor bank, and the capability of producing a square or sine-wave alternating magnetic field up to several kilogauss over a 75 cm^3 volume. (auth)

34058 (WANL-PR(P)-003) DETERMINATION OF THE WELDABILITY AND ELEVATED TEMPERATURE STABILITY OF REFRACTORY METAL ALLOYS. Third Quarterly Report, December 21, 1963–March 21, 1964. G. G. Lessmann and D. R. Stoner (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Contract NAS-3-2540. 87p. (NASA-CR-54088)

A study of the effects of weld parameter variations was initiated on seven alloys. The electron beam welding effort was completed for FS-85 and Ta-10W. TIG welding was initiated for these and B-66, C-129Y, Cb-752, D-43, and SCb-291. Bend test results on welds and base metals are summarized. Restraint weld tests were completed. Bead-on-plate patch tests for sheet material and circular groove restraint tests for plate material were used. A double U butt weld joint configuration was te welded and found to be satisfactory for welding the $\frac{3}{8}$ inch plate. The TIG weld atmosphere monitoring equipment was modified. An evaluation was made of the effect of variation of vacuum pressure in the range of 10^{-3} to 10^{-5} torr on EB weld contamination. No differences were noted in pickup of contaminants in the EB welds. Neoprene, butyl rubber, and polyvinyl chloride weld chamber gloves were tested with respect to the permeability of the glove materials to oxygen and water vapor. The polyvinyl chloride gloves were unsatisfactory. Four ultra-high vacuum aging furnaces for use in the thermal stability studies were checked out at the factory, delivered, and installed. These units are described. (N.W.R.)

34059 (WANL-PR(Q)-003) DEVELOPMENT OF DISPERSION-STRENGTHENED TANTALUM BASE ALLOY. Quarterly Progress Report No. 3, December 20, 1963–March 19, 1964. R. W. Buckman, Jr., and R. T. Begley (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Contract NAS 3-2542. 73p. (NASA-CR-54105)

The preparation, fabrication, and properties of tantalum–tungsten alloys with additions of hafnium, carbon, molybdenum, nitrogen, rhenium, and zirconium are evaluated. Fabricability and weldability are affected by the total solute addition, total carbon addition, and the ratio of the reactive (Hf) metal addition to the carbon addition. Hot hardness measurements and recrystallization studies show an increase in recrystallization temperature by as much as 400°C and improvements in hot hardness by as much as 10 to 20% by minor substitutions of rhenium, molybdenum, and zirconium for the tungsten and hafnium. The addition of 500 ppm carbon to T-111 and compositions containing a total of 12 wt % W + Hf results in a pronounced increase in the TIG weld bend transition temperature. Information is also included on upset forging, melting, rolling to 0.04 inch thick sheet, metallography, tensile testing, heat treatments, creep properties, stress-rupture, extrusion, ductility, and chemical analysis. (N.W.R.)

34060 (EURAEC-1062) [CORROSION TESTS IN STEAM]. Quarterly Report No. 8, January 1–March 31, 1964. (Compagnie Pechiney, Paris). May 19, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 067-62-4-RDF. 27p. (A translation)

The absorption of hydrogen by zirconium, zirconium–tin–vanadium alloys, zirconium–nickel alloys, and Zircaloy-2 during corrosion by steam at 350, 400, and 480°C is studied. It is shown that increase in vanadium content is harmful to corrosion resistance in steam at 350°C, but that the addition of tin is beneficial. Annealing and quenching from the beta area onwards followed by tempering is favorable to corrosion resistance. The assay of hydrogen in zirconium using the Dosivac is described. The fabrication of small plates for these tests by arc fusion is discussed. The thermal stability tests show the effect of tin additions on the mechanical properties of quenched and low temperature tempered alloys. (N.W.R.)

34061 (FTD-TT-64-350) PREPARATION OF MOLYBDENUM SINGLE CRYSTALS BY ELECTRON-BEAM FLOATING-ZONE MELTING. Nai-pen Ming, Ts'un-yi Fan, Ch'i Li, Yu-shan Hsu, and Tuan Feng. Translated from Wu Li Hsueh Pao, 19: No. 3, 160-4(1963). 12p.

A brief description is given of the design and operation of a 1.5-kw electron-beam floating-zone melting unit. This unit was used to prepare molybdenum single crystals, 4 mm in diameter and 2 to 5 cm long, with controlled orintation. The molybdenum single crystals prepared showed no preferred orientation; microscopic examination disclosed a large number of terraces on the crystal surface (with step heights ranging from 2.3×10^{-5} to 6.3×10^{-4} cm), which were tentatively identified as evaporation terraces. (auth)

34062 REFRACTORY METALS FOR THERMAL-PROTECTION SYSTEMS. Eldon E. Mathauser (Langley Research Center, Langley Field, Va.). Astronaut. Aeronaut., 2: No. 7, 66-8(July 1964).

The status of refractory-metal sheets for thermal-protection systems is summarized. Availability, fabrication, protective coatings, and mechanical and physical properties are covered. (D.C.W.)

34063 THE INVESTIGATION OF PASSIVATING OXIDE LAYERS ON ZIRCONIUM METAL USING SMALL SINGLE SHOT ANODIC CURRENT PULSES. P. Weisgerber (Centre d'Etude de l'Energie Nucléaire, Mol, Belg.). Electrochim. Acta, 8: 937-47(1963).

Passivated metals such as Al, Nb, Ta, and particularly Zr were anodically polarized in aqueous sulfate solution by single shot intensiostatic charge pulses, and the overtensions recorded on CRO photograms. The initial slope of the overtension/time curves is given by the capacitance of the passivating oxide film. The slope decreases when, with rising electrical field strength across the oxide film, the ionic current flow increases. In agreement with the known theories, a straight line results from plots of the overtension measured at charge densities of 10^{-4} C/cm^2 vs the logarithm of the current density. From the slope of this straight line the thickness of the passivating layer can be obtained without interference of the surfaces roughness. For the measurement of the thickness of the passivating oxide film of an individual specimen surface, two successive pulses were applied, the first of 3.3×10^{-5} A/cm^2 and the second of 3.3×10^{-3} A/cm^2 current density; the pulse duration was so chosen that each pulse represented the same charge density, 10^{-4} C/cm^2. Thus the modifications of the original surface state of the electrode metal caused by each pulse were negligible. From the difference of the maximum overtensions and the difference of the logarithms of the current densities of the two pulses the thickness of the passivating oxide film of the investigated sample can be calculated. The method was checked measuring zirconium samples after gravimetrically controlled oxidation. The results obtained applying the method to differently prepared metal surfaces are discussed. (auth)

34064 PREPARATION OF HIGH PURITY BeO POWDER. E. S. Funston, W. J. Kirkpatrick, and P. P. Turner

(General Electric Co., Richland, Wash.). J. Nucl. Mater., 11: 310-19(Apr. 1964).

A method is described for the preparation of high-purity beryllium oxide in which advantage is taken of the differences in solubility of beryllium basic acetate and other acetates in various solvents. The resulting beryllium acetate is readily hydrolyzed to form a precipitate of spherical beryllium hydroxide agglomerates that can be calcined to high purity beryllium oxide. (auth)

34065 FINE-GRAINED TUNGSTEN POWDER. Metal Ind. (London), 104: 314-15(Mar. 5, 1964).

The use of gas-pressure bonding process for densification of fine-grained tungsten powders for the production of shapes with good thermal stability was investigated. Bonds of high strength were formed between the granules at temperatures low enough to prevent recrystallization of the tungsten. Emphasis was placed on the mechanical properties of the structure as affected by time and temperature of anneals. (Rev. Metal Lit., 21: (June 1964))

34066 THE 1964 INSTITUTE OF METALS LECTURE ON THE POSSIBLE IMPACT OF QUANTUM MECHANICS ON PHYSICAL METALLURGY. Jacques Friedel (Faculté des Sciences of Paris, Orsay, France). Trans. AIME, 230: 616-32(June 1964).

Some quantum mechanical concepts provide a framework for analyzing the electronic structure of conductors and thus predicting some of their physical properties. The present status of three such concepts is considered. The reciprocal space is connected with the periodicity of the lattice and with the Hartree approximation; it applies directly to all nonmagnetic metals and can be used to describe most of their physical properties if care is taken in energy counts for cohesive properties; the nearly free electrons and tight-binding approximations are useful in analyzing "normal" and "transitional" metals, respectively. Extensions must be made to treat magnetic metals, especially rare earths metals, and alloys. Charge oscillations appear at the edge of any localized perturbation in a conductor; their importance in studying physical properties of all defects (impurities, dislocations, surfaces, and so forth) is stressed; the cases of concentrated alloys and magnetic and liquid metals is considered. Their relation and the concept of reciprocal space is stressed. Resonance effects are most spectacular in effects of virtual bound levels; various cases of such levels due to impurities are reviewed. Resonance effects in pure metals are also considered. (auth)

34067 ON THE ARC REDUCTION PROCESS FOR THE PRODUCTION OF CRUDE COLUMBIUM METAL. Hirozo Kimura and Yasuo Sasaki. Trans. Natl. Res. Inst. Metals (Tokyo), 5: 274-9(1963).

Crude Nb metal, containing about 99% Nb, was obtained from a mixture of Nb_2O_5 and NbC by arc reduction. Mixtures of Nb_2O_5 powder and NbC powder were pressed into briquettes. Arc melting was done in a laboratory furnace with tungsten electrodes and a water-cooled Cu crucible. The effects of melting time, argon pressure, and number of remeltings on the reaction were investigated. The purity of reductants, composition of the furnace gas, and weight losses during arc melting were also examined. (Rev. Metal Lit., 21: (June 1964))

34068 THE SCIENCE AND TECHNOLOGY OF TUNGSTEN, TANTALUM, MOLYBDENUM, NIOBIUM, AND THEIR ALLOYS. BASED ON AN AGARD CONFERENCE ON REFRACTORY METALS HELD AT OSLO UNIVERSITY CENTRE, OSLO-BLINDERN, NORWAY, 23-26 JUNE 1963. N. E. Promisel, ed. Oxford, Pergamon Press, 1964. 596p. (AGARDograph 82). £7 net.

Papers prepared for the Oslo Conference on Refractory Metals, but not presented there in detail, are given, along with syntheses of the papers and discussions. Separate abstracts were prepared for 25 of the 28 papers. One paper was previously abstracted for NSA as 17: 36228. (M.C.G.)

For abstracts of individual papers see: 33515, 33516, 33603, 34069, 34083, 34084, 34101, 34102, 34103, 34104, 34105, 34106, 34107, 34108, 34109, 34201, 34202, 34203, 34204, 34205, 34206, 34207, 34208, 34209, and 34210.

34069 THE TREND AND STATUS OF DEVELOPMENT OF REFRACTORY METAL ALLOYS. A. B. Michael and W. O. Gentry (Fansteel Metallurgical Corp., Chicago). p.111-29 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

The development of Mo, Nb, Ta, and W alloys for elevated temperature applications is reviewed. The effects of alloying and metallurgical treatment on their elevated-temperature strengths are discussed in terms of available semi-empirical concepts for strengthening. The importance of such factors as low-temperature ductility, fabricability, and weldability is considered. (M.C.G.)

34070 PROCESS FOR THE PRODUCTION OF BERYLLIUM HAVING INCREASED DUCTILITY AT HIGH TEMPERATURES. Alfred John Martin, Frederick Morrow, and Alexander Baillie Brown (to Babcock & Wilcox, Ltd.). British Patent 965,710. Aug. 6, 1964. Filed Aug. 19, 1959.

A process is given for obtaining Be with increased ductility at 300 to 600°C, i.e., a ductility of at least 30% at 300 to 400°C and at least 40% at 400 to 600°C. In this process, thermally reduced Be is held at 600 to 850°C for 12 to 72 hr and then cooled to room temperature. Since this process does not work with electrolytic Be, the ductility increase is probably due to precipitation of impurities. The impurity contents of the Be should be as follows: Fe 1000 ppm, Al 660 ppm, Si 850 ppm, Mg 10 ppm, Mn 70 ppm, Ni 220 ppm, Cu 10 ppm, Cr 100 ppm, O_2 250 ppm, and Be carbide 400 ppm. (D.L.C.)

34071 FUEL COMPOSITION FOR NUCLEAR REACTORS. (to U. S. Atomic Energy Commission, Germantown, Md.). British Patent 964,851. July 22, 1964. Priority date Feb. 6, 1962, United States.

A refractory fuel material is described which has a high oxidation resistance, high strength, high density, and good thermal conductivity at temperatures up to 1500°C. The fuel material comprises a mixture of SiC, USi_3, and nickel aluminide and optionally $MoSi_2$. ZrO_2 may also be added to improve the density. Several examples are given of the preparation and fabrication of the material into fuel tubes. (D.L.C.)

Corrosion

34072 (AWRE-O-40/64) URANIUM COMPATIBILITY STUDIES. PART 3. THE INFLUENCE OF OXYGEN ON THE URANIUM–WATER REACTION. M. McD. Baker, J. W. Bleloch, N. Less, and S. Orman (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). June 1964. 20p.

The effect on the rate of the uranium–water reaction of the addition of oxygen has been studied over a range of oxygen and water pressures. The retarded rate is not dependent on the oxygen pressure. Oxygen is consumed during the retardation period and the mechanism of its consumption has been elucidated. (auth)

34073 (GEAP-4438) SODIUM MASS TRANSFER. XI. 1963 TEST RUN REPORTS (JANUARY–JUNE). R. W. Lockhart, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Feb. 1964. Contract AT(04-3)-189. 204p.

Corrosion data and exposure effects were obtained by subjecting metallic samples, during programmed test runs to flowing sodium in 6 test loops fabricated with various combinations of three selected materials, Type 316 stainless steel, 2¼ Cr–1 Mo alloy steel, and 5 Cr–½ Mo–½ Ti alloy steel. Information produced by each test run, including operational and metallurgical data and analyses, is presented. Data are shown in tables, graphs, and drawings. (M.C.G.)

34074 (IDO-24460) ADVANCED TEST REACTOR. INVESTIGATION OF THE CORROSION BEHAVIOR OF MATERIALS OF CONSTRUCTION. Research Report No. 5448. D. W. Koch, K. F. Riskevics, and E. E. Ritchie (Babcock and Wilcox Co. Research Center, Alliance, Ohio). Aug. 1, 1963. Contract AT(10-1)-1075. 197p. (E-2439)

Includes Appendices A through I.

The test program was conducted to investigate the corrosion behavior of the materials of construction at the anticipated operating conditions for the Advanced Test Reactor. The test program was divided into two phases. First, a series of twelve 300-hour screening tests were performed to define the factors affecting the corrosion of beryllium and determine the optimum operating conditions that would minimize the corrosion of the various materials. The parameters investigated include temperature, pH, oxygen content, velocity, ion exchange flow rate, and beryllium surface area to loop volume ratio. The second phase consisted of a 4000-hour long term test conducted at the optimum conditions as determined by the screening tests. The results of the test program indicated that all of the materials tested, except the hard-coated aluminum alloys, were suitable for service at the contemplated reactor operating conditions. Beryllium corrosion was found to be extremely sensitive to environmental changes within the range of ATR operating conditions. (auth)

34075 (NASA-CR-54071) CAVITATION DAMAGE IN LIQUID SODIUM. Technical Report 235-1. H. S. Preiser, A. Thiruvengadam, and C. E. Couchman, III (Hydronautics, Inc., Laurel, Md.). Apr. 1, 1964. Contract NASr-105. 88p.

Test facilities and techniques to conduct investigations in high temperature liquid metals have been developed in this program. The considerations that governed the selection and development of a suitable laboratory facility are discussed. The operational experience gained from using such a facility is presented. Based on this experience, an improved facility has been developed for testing refractory metals at temperatures up to 1500°F in liquid sodium. The high frequency fatigue testing techniques developed for these investigations are described. Experiments designed to standardize magnetostriction test parameters are included along with a description of the components of the magnetostriction apparatus. An analysis was made to correlate the cavitation damage resistance of several metals in liquid sodium with their mechanical properties. The intensity of cavitation damage in impure liquid sodium at 400°F was estimated from these data. Future work in the areas of cavitation damage resistance of refractory metals is also outlined. (auth)

34076 (TID-8540(p.213-330)) BEHAVIOR OF CLADDING MATERIALS IN WATER AND STEAM ENVIRONMENTS. Sherman Greenberg, ed. (Argonne National Lab., Ill.).

A review is presented of metals and alloys for use in power-reactor fuels fabrication. Emphasis is placed on corrosion behavior. Aluminum, iron, nickel, and niobium alloys for liquid-water systems, and zirconium and nickel alloys and ferritic stainless steels for superheated steam systems are considered. Specific reactor applications for specific reactors are included. A bibliography of 269 references is presented. (R.E.U.)

34077 OXIDATION OF URANIUM–ALUMINIUM INTERMETALLIC COMPOUNDS. PART I. KINETIC STUDIES. P. R. Openshaw and L. L. Shreir. Corrosion Sci., 3: 217-37(Dec. 1963).

The kinetics of oxidation of the intermetallic compounds UAl_2, UAl_3, and UAl_4-eutectic alloys containing various proportions of UAl_4 were determined by microbalance methods in the temperature range of 250 to 600°C. Alloys with high amounts of UAl_4 were prepared by centrifuging at temperatures just below the compound melting point. Oxidation occurs linearly for alloys containing large amounts of UAl_4 in the 350 to 550°C range, but at 600°C a cubic rate law was observed. The lower rate of oxidation at 600°C appears to be due to a physical change in the oxide. Interpretation of results obtained with two-phase alloys was made by considering oxidation behavior of single phases. A quantitative relationship in agreement with experimental results was derived. (Rev. Metal Lit., 21: (June 1964))

34078 STUDY OF THE KINETICS AND MECHANISM OF OXIDATION OF NIOBIUM–MOLYBDENUM ALLOYS. D. A. Prokoshkin, E. V. Vasil'eva, and A. M. Ryabyshev. Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 10: 233-9(1963).

Alloys of niobium with 0.5 to 50 wt % molybdenum were vacuum melted with a nonconsumable tungsten electrode in a water-cooled copper mold in an atmosphere of purified argon at a pressure of 200 to 300 mm Hg. To provide better fusion of the components and to obtain a uniform composition, the ingots were remelted several times. Oxidation resistance of the alloys was determined gravimetrically from the weight gain after heating for 1, 2, 3, 5, and 10 hours in air at temperatures of 1000, 1100, and 1200°C. The effect of Mo in amounts up to 50% on the oxidation rate of niobium was studied between 1000 and 1200°C in air. Alloying with Mo in amounts up to 10% lowers the oxidation rate of niobium at the indicated temperatures. As temperature rises the oxidation-rate minimum shifts toward higher Mo concentrations. A drop in oxidation resistance at a high Mo content is due to the formation of volatile Mo trioxide. The method of continuous weighing was used to study the kinetics of high temperature oxidation of the alloys. It was found that the oxidation of the alloys obeys the parabolic law during the initial period and the linear law thereafter. X-ray-diffraction analysis of the oxide scale showed the presence of a solid solution $(Nb, Mo)_2O_5$ whose lattice parameters decrease with increasing Mo concentration in the alloy. The scale on alloys with a Mo concentration above 5 wt % has a monoclinic lattice

similar to that of β-Nb_2O_5, but differing in the fine structure. It was found that Mo trioxide is not preserved in the structure of the scale at temperatures between 1000 and 1200°C. (OTS)

34079 HIGH-TEMPERATURE OXIDATION OF NIOBIUM ALLOYED WITH TITANIUM AND MOLYBDENUM. G. V. Estulin and N. N. Burova. Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 10: 257-63(1963).

Studies were made on the oxidation-resistant binary alloys of niobium with 5% Mo and 7% Ti, and a ternary alloy of niobium with 5% Mo and 7% Ti. The rates of scale formation and gaseous diffusion in these alloys were studied. It was found that alloying with titanium and molybdenum increases the oxidation resistance of niobium between 1000 and 1200°C. At 1000 and 1100°C, the resistance to scaling of niobium alloyed with titanium and molybdenum is the same; at 1200°C alloys with 7% Ti were more oxidation resistant than alloys containing up to 5% Mo. The external scale of the investigated alloys consisted of niobium pentoxide. In the layer adjoining the metal, niobium pentoxide (with a preferred orientation) and niobium oxide were observed. It was found that an intermediate oxide layer of the composition Nb_4O was formed in the substrate of niobium alloyed with titanium. In contrast to molybdenum, besides stabilizing the lower oxides of niobium, alloying with titanium considerably decreased the rate of gaseous diffusion in the metal. In the oxidation of alloys containing molybdenum, the latter burned off from the surface layer. When titanium was introduced into an alloy containing molybdenum, the intermediate oxide layer Nb_4O decreased the rate of diffusion of alloying elements through the substrate; the concentration of alloying elements in the surface layer decreased only slightly. Alloys with titanium did not differ in strength from the unalloyed metal. Alloying with molybdenum hardened niobium alloys substantially. Combined alloying with titanium and molybdenum provided the best combination of strength, resistance to oxidation, and resistance to gaseous diffusion. (OTS)

34080 X-RAY DIFFRACTION STUDY OF THE HIGH-TEMPERATURE OXIDATION OF A NIOBIUM–MOLYBDENUM–CHROMIUM ALLOY. A. F. Gerasimov, T. V. Ushkova, and N. Shkerin. Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 10: 264-9(1963).

Alloys of niobium with molybdenum and chromium were oxidized between 800 and 1200°C. Kinetics were studied in some of the experiments, and phase composition of the oxidation products was determined by x-ray diffraction in all cases. Cr–Kα and Fe–Kα radiation was used. To prepare the samples, alloys of the following compositions (in at. %) were employed: 87.5 Nb–7.5 Cr–5 Mo; 90 Nb–5 Cr–5 Mo; and 93 Nb–2 Cr–5 Mo. It was found that the combined presence of Mo and Cr in Nb leads to an increased resistance to oxidation between 800 and 1200°. X-ray-diffraction analysis showed that when ternary niobium alloys are oxidized, a scale with an Nb_2O_5 lattice is formed on pure niobium. It was concluded that two modifications of the oxide forming on the alloy are present: α- and β-Nb_2O_5. An abnormally high rate of oxidation of alloys was observed at 800°C, which was attributed to the allotropic transformation $\alpha \rightarrow \beta$-Nb_2O_5. The effect of molybdenum and chromium on the oxidation of niobium is due to their dissolution in the oxide lattice. A hypothesis is presented regarding the oxidation mechanism of niobium and a number of its alloys. (OTS)

34081 DEFORMATION OF ZIRCONIUM SHEETS DURING OXIDATION. G. Saur, H.-J. Laue, and H. Borchers (Technische Hochschule, Munich). Metall, 18: 704-8(July 1964). (In German)

Buckling occurs in Zr sheets during oxidation when the oxidation velocity on the two sides of the sheet are different. The deformation starts when the oxide layer on one side begins to split and is produced by compressive stress in the still undisturbed oxide layer. Origin of the different oxidation velocities can be different surface roughness or texture variations. From the buckling of the samples, which are covered on only one side with an oxide layer, it was concluded there is a compressive stress of about 50 p/mm^2 in the touching oxide/metal surfaces. Two possible reasons of the occurrence of a transition law between the parabolic and cubic time laws are discussed. (tr-auth)

34082 CORROSION OF ZIRCALOY FUEL CLADDING. THE INFLUENCE OF HIGH HEAT FLUXES. I. H. Dyce (Babcock and Wilcox, Ltd., London). Nucl. Eng., 9: 253-5(July 1964).

The variation in Zircaloy-2 corrosion rate and, therefore, hydriding as a function of heat flux was calculated in the temperature range 580–680°F. The acceleration in corrosion rate and hydriding is such that the time taken to reach a hydride level of 500 ppm is reduced by about 50% for a 1,000,000 Btu/ft^{2}h heat flux, as compared with the predicted time under isothermal conditions. The reduction in life (based on a hydride limit) for a 100,000 Btu/ft^{2}h increase in heat flux is only 5 per cent. (auth)

34083 FUNDAMENTALS OF REFRACTORY METAL-GASEOUS ENVIRONMENT INTERACTION. Rudolph Speiser and G. R. St. Pierre (Ohio State Univ., Columbus). p.289-330 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

The oxidation behavior of molybdenum, tungsten, niobium, and tantalum in gaseous atmospheres such as air, O_2–N_2, CO–CO_2, and H_2–H_2O mixtures at elevated temperatures is reviewed. Comprehension of the mechanism of oxidation was found to require knowledge of the equilibria between the refractory metals and oxygen as well as the irreversible reaction of these metals with oxygen. Refactory metal-oxygen equilibria are discussed and the kinetics of oxidation of each refractory metal are reviewed. (auth)

34084 EFFECTS OF ALLOYING AND COATING ON THE ELEVATED TEMPERATURE CORROSION RESISTANCE OF THE REFRACTORY METALS. M. A. Levinstein and S. T. Wlodek (General Electric Co., Evendale, Ohio). p.331-56 "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Concepts that proved useful in the design of oxidation-resistant alloys of refractory metals and protective coatings for them are reviewed. Mo, W, Nb, and Ta alloys are described. Research on coatings is also discussed. (M.C.G.)

Fabrication

Refer also to abstracts 35093, 35126, and 35169.

34085 (BRB-81) QUARTERLY PROGRESS SUMMARY [ON U FABRICATION] JANUARY–MARCH 1964. (Reactive Metals, Inc., Seymour, Conn.). June 3, 1964. Contract AT(30-1)-1405. 58p.

The realm of extrusion conditions which can be employed to avoid excessive duplexing in Mark V-B extrusions from

9 in. billets was established. There does not appear to be excessive versatility at this starting billet size, because of force requirements near the maximum press capacity. A test was concluded to demonstrate electrochemical drilling of uranium billets for extrusion. Very high yields can be anticipated from this machining process. A basic heat treatment study was made on uranium billets for extrusion. Both the number of cycles and the time at each cycle were investigated. It appears that the triple beta heat treatment can be reduced on the basis of the metallurgical evaluations. Studies were performed on various types of lubricants. Difficulties are encountered in maintaining adequate dimensional control in pierced billets. Attempts were made to obtain a double Mark V-B element using high energy rate forming methods. (auth)

34086 (GEAP-4435) AEC FUEL CYCLE PROGRAM—DESIGN AND FABRICATION OF SPECIAL ASSEMBLY 9-L. IRRADIATION PERFORMANCE TEST OF UO_2–CERMET FUEL. S. Y. Ogawa (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Mar. 1964. Contract AT(04-3)-189. 50p.

A UO_2–Mo cermet fuel assembly was fabricated for long-term irradiation performance testing in the Vallecitos Boiling Water Reactor. The design and fabrication histories of this assembly are described and pre-irradiation data on each individual rod are presented. Molybdenum was added to improve the bulk thermal conductivity of the fuel, so that fuel temperatures would remain comparatively low during high-power level operation of the fuel element. The molybdenum was incorporated into the compacts either as fibers or as a thin coating on individual UO_2 particles. Fuel pellets were produced from these materials by vacuum hot pressing. Pellets having the fibers contained 20 vol %(~20 wt %) molybdenum and had densities from 94 to 95% theoretical. The pellets made from the coated UO_2 particles had a metal content of about 16 vol % (~17 wt %) and had densities that ranged from 84 to 96% of theoretical and averaged 89%. The distribution of the molybdenum in both types of cermet fuels appeared favorable to good heat transfer. The fibers were oriented predominantly in the radial planes of the pellet as a result of the uni-directional compaction during the hot-pressing operation. In the pellets made from the coated particles, a continuous network of molybdenum occurred as a result of the coating welding together during the hot-pressing operation. The test assembly contains eight fuel rods; three contain the UO_2–Mo fiber cermet, three contain the cermet produced from the coated particles, and two are for reference and contain the conventional sintered UO_2 pellet fuel. The nominal outside diameter of the fuel rods is 1.308 cm (0.515 inch), and the clad wall thickness is 0.051 cm (0.020 inch). The cladding material is Type-304 stainless steel. The fuel pellets were all centerless ground to achieve a uniform outside diameter and thereby control the pellet-to-clad diametral clearance within a range of 0.076 to 0.102 mm (0.003 to 0.004 inch). Operation of the fuel rods will be at high specific power levels with surface heat fluxes of about 157 w/cm^2 (~500,000 Btu/hr-ft^2). The assembly was designed for a lifetime of 4.1×10^{20} fission/cc (15,000 Mwd/t) exposure. (auth)

34087 (ORNL-3644) FABRICATION DEVELOPMENT OF U_3O_8–ALUMINUM COMPOSITE FUEL PLATES FOR THE ADVANCED TEST REACTOR. D. O. Hobson, R. L. Heestand, and C. F. Leitten, Jr. (Oak Ridge National Lab., Tenn.). July 1964. Contract W-7405-eng-26. 59p.

Procedures have been developed for fabricating fuel plates for the Advanced Test Reactor. This reactor will contain nine flux traps, formed by a serpentine arrangement of 40 wedge-shaped fuel elements. Each element contains 19 fuel plates, 49½ in. long, which consecutively vary in both width and radius of curvature about a common center. Innovations in fabrication techniques were required because of the unusual length of the plates, the close tolerances placed on the fuel core dimensions, and the need for 19 different widths. Pressed-powder cores of U_3O_8, B_4C, and type X8001 aluminum were roll clad in type 6061 aluminum by the picture-frame technique. The principal innovations were the use of tandem cores and the use of cross rolling. The required variety of core widths was obtained by the latter with the use of only three pressing dies. To develop a reliable rolling schedule, the effect of rolling parameters on plate properties was studied. The effects of roll diameter, reduction per pass, billet width, and other parameters on core spread, thickness variation, core geometry, and other dependent variables were determined. Particular attention was paid to core spread, because this phenomenon contributes an important part in reproducibly controlling the core width during the high reduction needed to achieve the 48-in. core length. The final fabrication procedures successfully produced a high yield of high-quality plates. The fabrication schedules evolved, which are based on experimental determinations of the effects of rolling parameters on core geometry, are presented along with the billet designs, the loading specifications for the 19 different compact sizes, and the conformity of the finished plates to dimensional specifications. With minor alterations due to equipment differences, the methods should enable a commercial manufacturer to produce ATR fuel plates within tolerance specifications. (auth)

34088 (ORNL-3645) CHARACTERIZATION OF SPHEROIDAL UO_2 PARTICLES AND STUDIES OF FABRICATION VARIABLES FOR CORE B FUEL PLATES OF THE ENRICO FERMI FAST BREEDER REACTOR. A. J. Taylor, J. H. Cherubini, J. M. Robbins, and M. P. Haydon (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 68p.

During roll cladding, dispersions of spheroidal UO_2 in stainless steel often suffer particle degradation that leads to unacceptable fuel plates. Several physical tests on commercially produced −100 +140 mesh spheroidal UO_2 have been evaluated as criteria for particle quality by correlation of the results with microstructures of the roll-clad dispersions. Determinations of microhardness, crushing strength by a simple test, attrition resistance, grain size, and surface area did not satisfactorily characterize the particles. A rapid mercury pycnometric technique, despite inaccuracy, could distinguish both the highest grade and the poorest grade of UO_2 spheroids, but could not clearly distinguish between the intermediate grades that may sometimes be acceptable. A more complete characterization was obtained by density determination and microscopic observation on particles embedded in an epoxy resin. A study of the effect of rolling temperature on plate quality revealed an optimum furnace temperature of 1150°C, somewhat lower than previously established. Core-clad bonding is best for this rolling temperature. Lower temperatures gave improved surface finish but excessive particle degradation. The quality of poorer grades of UO_2 was improved by firing in hydrogen at 1750°C. Cold rolling of dispersion plates degraded both superior and poor quality particles similarly. Particle degradation was less in plates fabricated by a more severe hot-rolling schedule. (auth)

34089 (EURAEC-915) WELDING OF VERY THICK STEELS. Quarterly Report No. 9, October 1–December 31, 1963. (Ghent. Rijksuniversiteit and Soudometal, S. A., Brussels). Work Performed under United States–Euratom Joint Research and Development Program. Contract 042-61-9 RDB. 214p. (A translation)

Topics covered on the welding of very thick steels include: a statistical study of the influence of automatic welding parameters on the impact strength mechanical properties of deposited metals; study of restoration of filler metals and 17C and 37A steels embrittled by 10% strain at 300°C; examination of creep curves obtained with tests on filler metals at 450°C and under a stress of 24 kg/mm^2; improvement of artificial flaw creation technique (cracking) in automatic welding; determination of the tensile properties of filler metals and 13C, 17C, 23A, 23C, 27A, and 33A steels at various temperatures; determination of the Robertson arrest temperatures in the transformation zones of 30-mm thick asymmetric joints manually and automatically welded; determination of the semi-global tensile properties of 30-mm thick manually welded plates containing a bonding flaw; determination of the impact strength properties across heat affected zones and possibly tensothermally embrittled during manual welding in two positions and with two procedures; and determination of Robertson arrest temperature on 100-mm thick 17C and 37A steels using the 6000 ton press. (N.W.R.)

34090 (EURAEC-1015) NUCLEAR VAPOTRON. Special Technical Report No. 4. (Compagnie Francaise Thomson-Houston, Paris; Société Alsthom, Paris; and Allgemeine Elektrizitatsgesellschaft, Frankfurt am Main). Work Performed under United States–Euratom Joint Research and Development Program. [nd]. Contract 050-62-5 RDC. 29p. (A translation).

The "nuclear vapotron" is a cladding concept for the fuel elements of boiling reactors, comprising prismatic claddings with irregular external cross sections (e.g., gear-teeth, thick fins, triangular shapes, etc.). The purpose of the nuclear vapotron concept is the stabilization of the heat transfer characteristics of the fuel elements. A report is presented of low-pressure burnout studies on short test elements having characteristic vapotron cross sections. (T.F.H.)

34091 CEMENTATION COATINGS FOR REFRACTORY METALS. Burton S. Payne, Jr. (Pfaudler Co., Rochester, N. Y.). Am. Ceram. Soc. Bull., 43: 567-71(Aug. 7, 1964).

It is shown that process variations can strongly influence the performance of oxidation-resistant coatings produced by the cementation process. The fact that general trends are effective over a wide difference in coating compositions and process conditions is illustrated by wide differences between the three model systems PFR-6, Cr–Ti–Si, and Si–Cr–Al. Data are presented that indicate that while these processes can be controlled, they are more complex than has been generally realized and must be studied carefully to arrive at the optimum results. (P.C.H.)

34092 ELECTRON BEAM WELDING OF REFRACTORY METALS. Mel M. Schwartz. Current Eng. Practice, 6: No. 6, 16-20(Dec. 1963).

Electron beam welding parameters were evaluated to determine the optimum welding conditions for fabrication of TZM Mo alloy honeycomb core and other refractory metal and refractory metal alloy structures used for reentry vehicles and rockets. The electron beam welding results were correlated with the results of other applicable welding processes. (Rev. Metal Lit., 24: (June 1964))

34093 IRON CONCENTRATION PHENOMENON IN THE VICINITY OF THE CATHODE DURING ELECTROREFINING OF URANIUM IN A MOLTEN SALT BATH. G. Chauvin, H. Coriou, and A. Simenauer (CEN, Saclay, France). Electrochim. Acta, 8: 323-32(1963). (In French)

During the production of high purity uranium by electrorefining in LiCl–KCl eutectic, impurities, notably iron, were found to concentrate in the layer of electrolyte next to the cathode. The phenomenon shows that the layer of electrolyte affected is about 100 μ thick and the iron concentration increases by a factor of about 100, from the external part of the layer to the surface of the cathode (the surface of the dendrites of refined uranium). The results are shown to have some relevance to knowledge of the general mechanism of electrorefining. This explains, for example, why the purity of the refined uranium depends as often observed, on the quantity of residual electrolyte occluded in the dendrites after the final washing used to eliminate salts. (P.C.H.)

34094 SOME PRINCIPLES GOVERNING THE COMPACTION OF URANIUM DIOXIDE POWDERS. L. Jakesova. Hutnicke Listy, 18: 193-6(1963).

The compressibility of powder specimens of uranium dioxide as a function of the measured specific surface was studied. Characteristics of powders of UO_2 used and relationship between densities attained and compacting pressures are given. (Rev. Metal Lit., 21: (June 1964))

34095 GRINDING TUNGSTEN CARBIDE. Gerry Scheyer. Ind. Diamond Rev., 24: No. 279, 39-42(Feb. 1964).

Discussion is presented on centerless grinding, lapping, Blanchard grinding and Besley grinding method for tungsten carbides, tungsten carbides with additions of cobalt, titanium carbide, and tantalum carbide. Determination was made of the hardness and physical properties for grinding wheel abrasives. (Rev. Metal Lit., 21: (June 1964))

34096 VIBRATORY COMPACTION OF URANIUM DIOXIDE. I. EFFECT OF VIBRATION CHARACTER. Kaoru Naruki (Atomic Fuel Corp., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 58-67(May 1964).

The effect of vibration character (frequency, acceleration, etc.) on the compaction density was studied with sinusoidal wave vibrations generated by an electrodynamic shaker in order to optimize vibration conditions for obtaining high compaction densities. Fused UO_2 with a particle size distribution of –6, +12 mesh: 67.5 wt %, –40, +70 mesh: 20.0 wt %, –200 mesh: 12.5 wt % (mesh: US. Unit) was compacted into 40'' long, 0.5" outer diameter, and 0.035'' wall, 304 stainless steel tubes. Optimum results (88% of theoretical density) were obtained with a stepwise acceleration increase procedure. (auth)

34097 QUALITATIVE PROPERTIES REQUIRED FOR STEELS USED FOR THE MANUFACTURE OF NUCLEAR REACTOR PRESSURE VESSELS AND METALLURGICAL PROBLEMS OF THEIR MANUFACTURE. E. Marianeschi. Met. Ital., 56: 165-74(May 1964). (In Italian)

The present qualitative specifications for the steel of reactor pressures are presented. Areas in which future development of these steels are probable are illustrated. The metallurgical problems in the manufacture of pressure vessels are explained, and some considerations on the improvement of the fabrication technologies are reported. (tr-auth)

34098 THE ROLE OF PHASE RELATIONSHIPS IN THE ACTIVATED SINTERING OF TUNGSTEN. A. L. Prill,

H. W. Hayden, and J. H. Brophy (International Nickel Co., Bayonne, N. J.). Trans. AIME, 230: 769-72(June 1964).

The effect of group VIII transition-element additions on the sintering of tungsten powders is shown to be dependent on the phase relationships of the particular tungsten-Group VIII metal alloy system. The acceleration of sintering with nickel additions was diminished by alloying nickel with copper, which was known to diminish both the tungsten solubility in nickel and the solid-vapor surface energy. In work previously published on the effects of additions of Ni, Pd, Pt, Rh, Ru, and Ir, which form solid solutions or intermediate phases of wide composition width with tungsten, sintering behavior was independent of element concentration beyond that concentration necessary to form a continuous layer on the surface of the tungsten powders employed. The sintering behavior of tungsten with additions of iron or cobalt, which form intermetallic compounds with tungsten, was highly dependent on addition-element concentration. Additions in excess of amounts necessary to form continuous layers led to successively decreased sintering rates. (auth)

34099 ALUMINOTHERMAL PRODUCTION OF Al–Ce ALLOYS. V. A. Podergin and G. V. Samsonov. Tsvetn. Metal., No. 3, 59-62(1964). (In Russian)

The production of Al–Ce master alloy by compacting sintered-CeO_2 powder and Al powder into briquettes and sintering in vacuum at 900 to 1600°C was investigated. Determination was made of the heat of formation of Ce_2O_3, $CeAlO_3$, and metallic Ce and their corresponding endothermic and exothermic effects. Selection of optimum grain size of Al powder, density of briquettes, and sintering temperature to prevent oxide impurities in Al–Ce briquettes were also determined. (Rev. Metal Lit., 21: (June 1964))

34100 WELDING AND BRAZING TECHNIQUES FOR NUCLEAR REACTOR COMPONENTS. Gerald M. Slaughter. Monograph Series on Metallurgy in Nuclear Technology. New York, Rowman and Littlefield, Inc., 1964. 201p.

Current welding and brazing practices used in fabricating various reactor components and similar components, such as pipes in radiochemical facilities, are outlined. Among the components for which fabrication techniques are discussed are slugs, tubular and plate-type fuel elements, pressure and containment vessels, heat exchangers, and piping. Remote joining and cutting in repairs on radioactive equipment are also discussed. (D.L.C.)

34101 OUTLINE EVALUATION OF FABRICABILITY OF REFRACTORY METALS. J. T. Stacy. p.405-20 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

A number of fabricability tests applicable to refractory metal sheet are described and illustrative data presented. It was apparent that rate and temperature of forming took on a new significance in these tests. Also, the condition of the metal to be tested became very important. Laboratory test methods, which take these variables into account, were standardized. (auth)

34102 CONSOLIDATION OF REFRACTORY METALS. J. Wong (Supercon Co., Houston, Tex.). p.465-76 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Consolidation of refractory metals and their alloys by powder metallurgy, arc melting, and electron-beam melting methods is discussed. (M.C.G.)

34103 FLAT ROLLING OF REFRACTORY METALS. Paul S. Darby (Crucible Steel Co. of America, Midland, Penna.). p.477-84 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Special problems in rolling refractory metals are summarized as requirements for: thin and wide dimensions; flat and uniform thickness; contamination-free processing; and ductility. These problems are discussed in sequence and some suggestions are made as to solutions that have not as yet received sufficient attention. Available methods for fabrication of sheet are briefly mentioned. (P.C.H.)

34104 PRIMARY WORKING OF REFRACTORY METALS. A. S. Nemy (Thompson Ramo Wooldridge, Inc., Cleveland). p.485-502 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

The primary working of the refractory metals is reviewed in terms of current capability to produce mill products. The estimate was made that there exists the mere beginnings of a commercial capability. Technology was found lacking. A discussion of processing problems and a definition of the areas in which physical metallurgical data are needed are discussed. Emphasis was placed on what needs to be accomplished. (auth)

34105 SHAPE FORMING OF REFRACTORY METALS. M. E. Cieslicki. p.503-16 of "The Science and Technology of Tungsten, Tantalum, Molbydenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Shape forming processes, such as closed die forging, ring rolling, shear forming, tube and shape extrusions, and centrifugal casting, are discussed with emphasis on closed-die forging in hydraulic presses. The history of a W rocket-nozzle development is described at some length. It is pointed out that the details of structure and the property values necessary for success in service must be specified better so that more meaningful control can be practiced in forging. A description of electric-furnace heating and die-steel tooling is followed by a discussion of ingenious tailoring at the tool-work interface to improve oxidation protection, insulation, lubrication, and freedom from welding. The method of ensuring a fully deformed part through design is reported, and comments are given on the need for stress relief at 2000°F immediately after forging. Alternatives to hydraulic press forging, such as mechanical press forging, hammer forging, shear forming, extrusion, and several experimental processes are also discussed. (P.C.H.)

34106 MACHINING OF REFRACTORY METALS. Francis W. Boulger (Battelle Memorial Inst., Columbus, Ohio). p.527-40 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Machines, tools, and cutting fluids for turning, drilling, grinding, milling, and tapping refractory metals are discussed. Machining is described essentially as a metal fracturing process. It was concluded that nonconsistent quantitative correlations can be established to relate the behavior of refractory metals or their alloys between one machining operation and another and that on the whole the refractory metals are difficult to machine. Several alternative metal removal methods that do not depend upon the mechanical characteristics of the work piece but on such phenomena involving the surface as electrochemical behavior or electrical discharge techniques are also mentioned. (P.C.H.)

34107 FORMING OF REFRACTORY METAL SHEET. Roger A. Perkins (Lockheed Missiles and Space Co., Palo Alto, Calif.). p.541-56 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Critical problems that may arise in the production forming of refractory metal sheet are discussed. The experience of principal manufacturers in the U. S. is reviewed to develop a more clear perspective of forming capabilities and limitations of commercial sheet materials. Only those parts and materials that have advanced into a pre-production phase where sufficient experience has been gained to define behavior are considered. Additional work in relation to metal forming that could be done to exploit more fully the outstanding potential of these materials and to encourage commercial use also is discussed. Results are reported on the bending of sheet of various Nb, Mo, and Ta alloys and of unalloyed W to form sections, flanges, and contours. It was concluded that the major problems of forming refractory metal and alloy sheets are those of ensuring raw material that is sound and that has inherent ductility. (P.C.H.)

34108 JOINING OF REFRACTORY METALS. A. G. Metcalfe (SOLAR, San Diego, Calif.). p.557-70 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Niobium, tantalum, and moderate strength alloys of these metals can be welded to give strengths and ductilities approaching those of wrought sheet, by arc, electron-beam, and resistance welding. Alloys with restricted solubility for interstitials such as molybdenum, tungsten, plus tantalum and niobium alloys rich in molybdenum and tungsten, become irreversibly embrittled by recrystallization. This embrittlement is greater with resistance and arc welding than for electron-beam welding. High-temperature brazing causes general recrystallization and may not be practical for metals that embrittle. Reactive brazing and diffusion bonding are two approaches under study to avoid this problem, although both processes offer advantages for joining all the refractory metals. The problems of pin joints are formidable but such joints are needed for aerospace structures. (auth)

34109 FLOW TURNING (SHEAR FORMING) OF REFRACTORY METALS. Bernd Natter and Rudolf Machenschalk (Sinterstahl GmbH, Füssen, Ger.). p.571-80 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Properties of W and Mo and their alloys for flow turning or shear forming for use in rocket engine techniques are discussed. Three working methods (spinning, deep-drawing, and flow-turning) used on these metals are described. It was concluded that flow-turning can be applied to refractory metals as a rational and economical deformation method. However, the properties of such materials require working temperatures of about 800-1000°C. Where the final product must have close tolerances, subsequent machining or grinding is necessary. (P.C.H.)

34110 PRACTICAL ASPECTS OF BRAZING BERYLLIUM METAL. E. E. Weismantel and K. C. Taber (Beryllium Corp., Reading, Penna.). 15p. (CONF-511-2)

From American Welding Society 45th Annual Meeting, Detroit, May 1964.

Of the joining methods available, brazing appeared most widely applicable, producing joints at least equal in load-carrying ability to those obtained in fusion-welded metal with enough ductility to allow localized deformations. The brazing alloys used most widely are zinc, aluminum, or silver base. Copper and some of the common additions to silver brazing alloys may form brittle intermetallics. Both furnace brazing and braze-welding are discussed. The practical aspects of joint design and loading, as influenced by notch sensitivity and mode of failure, are considered. Failure locations and microstructures are illustrated for various joints and filler materials. In addition, the limitations of the brazing processes imposed by service temperature and the effect of brazing temperature on the properties are discussed. (auth)

34111 WELDING OF HEAVY BERYLLIUM–COPPER PLATES. E. E. Weismantel (Beryllium Corp., Reading, Penna.). 12p. (CONF-511-3)

From American Welding Society 45th Annual Meeting, Detroit, May 1964.

For alloys containing 1.6 to 2.0% beryllium, filler wire of the nominal 1.7% beryllium–copper is optimum. It is also preferred for the multipass welding of alloys containing lesser amounts of beryllium with certain restrictions because of thermal treatment, color, or conductivity. In the welding of plates up to three inches thick, the exceptional thermal conductivity of the beryllium–copper alloys requires the use of consumable electrode inert gas arc welding because of its concentration of heat and high capacity. Preheating in the range 200 to 400°F also minimizes the conductivity effect. The optimum post welding thermal treatment over-ages the material slightly but produces weld metal strengths above 130,000 psi, exceeding the minimum strength of the base metal. Because of the potential uses of these alloys in the chemical industry, the performance with regard to pressure vessel code requirements is of major interest. Tensile tests, side and face bend tests, radiographic examination, and microexamination showed that heavy plate weldments exceed the quality requirements of various codes. For welding alloys containing smaller amounts of beryllium, filler wire containing higher beryllium content avoids hot-tearing but requires modified thermal treatments to obtain acceptable base metal and weld metal properties. (auth)

34112 ELECTRON BEAM WELDING. Allan R. Pfluger (Lockheed Missiles and Space Co., Palo Alto, Calif.). Metals Park, Ohio, American Society for Metals, 1964, Technical Report No. W4 2.1, 38p. $3.00. (CONF-540-3)

From American Society for Metals Western Metal and Tool Conference, Los Angeles, Mar. 1964.

The characteristics of electron beam welding are described and compared with the widely used inert-gas tungsten-arc (TIG) process citing both advantages and disadvantages. Certain operating characteristics of particular interest to the electron beam welding operator are discussed. These include the effects of voltage, current, travel speed, and focus setting on weld shape and penetration. Also discussed are the flow of metal in the weld pool and techniques to minimize weld defects. The welding characteristics of selected material such as aluminum, magnesium, beryllium, are discussed and some weld properties given. The present status of electron beam welding equipment and trends for the future are also discussed, along with laser welding and comparisons made between the two processes. (P.C.H.)

34113 PRODUCTION, PROPERTIES AND WORKING OF HOT-PRESSED BERYLLIUM BILLETS. George E.

Meyer and John P. Denny (Beryllium Corp., Reading, Penna.). 15p. (CONF-628-1)

From 20th Annual Powder Metallurgy Technical Conference, Chicago, Apr. 1964.

Beryllium powder is hot-pressed in graphite or steel dies at 2000°F. Hot-pressed beryllium billets are fully dense and have minimum mechanical properties of 40,000 psi UTS, 30,000 psi YS, and 1% elongation. Such billets may be hot-worked by most conventional techniques. Extrusion, rolling, and forging produce material with higher mechanical properties and generate certain shapes impossible to obtain from direct hot-pressing. Details of hot-pressing operations are presented followed by a discussion of hot-working techniques. (auth)

34114 ZIRCONIUM-BASE BRAZING ALLOYS. (to Westinghouse Electric Corp.). British Patent 964,112. July 15, 1964. Priority date Oct. 17, 1960, United States.

A Zr brazing alloy is described for use in the fabrication of strong corrosion-resistant Zr-base alloy structures. The brazing alloy, which has a melting point of ~820°C and forms a well-bonded joint without a flux, comprises 3 to 8% Be; at least one of the group Cu, Fe, and Co; and balance Zr or a master Zr alloy (2.5% Sn and up to 2% of at least one of the group Fe, Ni, and Cr). The second constituent may be 5 to 20% Cu, 9 to 14% Fe, or 5 to 9% Co + 5 to 15% Cu. Several examples are given of the preparation and use of the brazing alloy. (D.L.C.)

34115 PROCESS FOR PREPARING URANIUM–URANIUM CARBIDE CERMET. (to Nihon Genshiryoku Kenkyu Sho). British Patent 965,895. Aug. 6, 1964. Priority date Oct. 5, 1962, Japan.

A process is given for preparing U–UC cermets directly from UO_2 and C. The process comprises mixing UO_2 and C powders, cold-pressing the powder mix, and heating the compact at a high temperature in vacuum. In one embodiment of the process, a 1:3 molar ratio of UO_2 and graphite is mixed, cold-pressed, and heated for 30 hr at 1800 to 1900°C and a vacuum of less than 10^{-3} mm Hg, and a cermet with a density of 16.9 g/cm^3 is obtained. (D.L.C.)

34116 PROCESS FOR PRODUCING OXIDATION RESISTANT REFRACTORY COATING ON DENSE GRAPHITE. James S. Kane (to U. S. Atomic Energy Commission). U. S. Patent 3,140,193. July 7, 1964.

A process is described for producing a high-temperature, oxidation-resistant refractory coating bonded by an intermediate interlocking layer upon a dense nuclear grade graphite. A composite silicon carbide-graphite layer is first produced upon the surface of the graphite, and the graphite is then removed by oxidation at elevated temperature, leaving a porous layer of silicon carbide on the surface. Additional molten silicon metal is applied to produce a layer interpenetrating and bonded to the porous layer of silicon carbide. The silicon layer may later be heated in contact with air to produce an oxide surface layer. (AEC)

34117 POWDERED TANTALUM ARTICLES. William H. Lenz (to U. S. Atomic Energy Commission). U. S. Patent 3,141,235. July 21, 1964.

A method is described for producing powdered Ta, Nb, Hf, Ti, or V articles (containing at least 1 wt % of yttrium) that are ductile, soft, and workable and can be sintered at a temperature of 1950°C. (AEC)

34118 PROCESS FOR THE FABRICATION OF NUCLEAR FUEL ELEMENTS. Joseph J. Hauth (to U. S. Atomic Energy Commission). U. S. Patent 3,141,911. July 21, 1964.

A process is described for compacting fuel powders in metal jackets by applying below-resonant, resonant and above-resonant vibrations to the open upper end, whereby vibrations travel down the tube. The procedure is repeated after the empty space formed by compacting is refilled with powder. (AEC)

Properties and Structure

Refer also to abstracts 34505 and 35198.

34119 (ATN-64(9236)-9) CREEP OF NIOBIUM AT LOW TEMPERATURES. General Research. G. A. Stone and H. Conrad (Aerospace Corp., El Segundo, Calif.). Feb. 21, 1964. 24p.

The activation energy, H, the activation volume, v*, and the frequency factor, ν, for the plastic deformation of niobium at low temperatures ($T < 0.2T_m$) were derived from creep tests. The values of H and v* for $\tau^* = 1$ kg/mm^2 were 0.75 ev and 47b^3 respectively, decreasing with increase in stress. The value of ν was 2×10^8 sec^{-1}. These values are in excellent agreement with those derived from constant strain rate tests, indicating an equivalence between the two types of testing. The present results support the idea that overcoming the Peierls-Nabarro stress is the rate-controlling mechanism during the plastic deformation of the bcc metals at low temperatures. Using the models of Seeger and of Dorn and Rajnak the kink energy in niobium is calculated to be 0.34 to 0.40 ev. (auth)

34120 (CNLM-5621) THE THERMAL CONDUCTIVITY OF URANIUM MONOCARBIDE. J. T. Sobon, A. D. Miller, and M. A. DeCrescente (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Apr. 2, 1964. Contract AT(30-1)-2789. 22p. (CONF-553-7)

From American Ceramic Society 66th Annual Meeting, Including Symposium on Nuclear and Space Applications, Chicago, Apr. 1964.

The high temperature thermal conductivity of uranium carbide containing small amounts of excess carbon varies from approximately 0.180 to 0.165 watt/cm-°C over the temperature range 950 to 1600°C. The thermal conductivity of UC is typical of metallic materials in that at high temperatures the conductivity is predominantly by electrons. The thermal conductivity decreased with increasing temperature up to 1600°C. The measured conductivity is very dependent upon the density and does not follow the 1-P relationship, where P = porosity. Although the results of this investigation are in fair agreement with the results of other investigators, a definite correlation cannot be made at this time because most investigators were working with fully dense material or they did not characterize their samples and/or test apparatus well enough to explain variations in their data. (auth)

34121 (DMIC-Memo-189) A REVIEW OF DIMENSIONAL INSTABILITY IN METALS. F. C. Holden (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Mar. 19, 1964. 39p.

Includes Appendix A.

Interest in maintaining very close dimensional control in precision parts has led to increased research activity in areas usually associated with the subject of dimensional stability. Included are the related phenomena of elastic-limit determinations, microcreep, microstrain, the mechanisms which cause them, and the practical

methods that can be employed to improve dimensional control. A discussion is presented of some of the problems that arise as a result of dimensional instability, and of information that has been made available to the Defense Metals Information Center. General recommendations are made for the processing of parts for use in applications where a high degree of dimensional stability is required. (auth)

34122 (GA-4900) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Summary Report, October 1, 1962–September 30, 1963. R. H. Chambers, T. A. Trozera, and J. L. White (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. 65p.

The effects of room-temperature prestrain on the low-temperature flow characteristics of Ta single crystals are studied. Studies are reported of: dislocation mobility in Fe–Si crystals; crystal defects and structure in bulk Ta and Ta foils; radiation effects on W single crystals; stored-energy release from Puron and Ferrovac E iron and Cu; and dislocation dynamics in metals, with particular reference to Nb. (T.F.H.)

34123 (HR-64-269) DISLOCATION CONFIGURATIONS AND THE INITIATION OF YIELDING IN MAGNESIUM OXIDE. Technical Report No. 24. R. J. Stokes and C. H. Li (Honeywell Research Center, Hopkins, Minn.). June 1964. Contract Nonr-4076(00). 38p.

A distinction is established between the role of "fresh," "aged," "grown in," and "high temperature" dislocations in the initiation of plastic flow in magnesium oxide single crystals. Grown-in dislocations in commercial purity crystals cannot be moved even under very high stresses and play no role in initiating slip at room temperature. Plastic deformation originates from fresh dislocation loops injected into the crystal surface. Fresh dislocations, introduced by prestrain at room temperature, become aged at high temperatures resulting in dislocation locking and an increase in stress to reinitiate slip. Weak locking occurs above 600°C and strong locking above 1200°C. Dislocations are almost completely immobilized by heating to 1900°C. Changes in dislocation configuration upon heating have been studied by etch pit and electron transmission techniques. It is proposed that weak locking is due to the diffusion of impurity ion-vacancy pairs to dislocations. Strong locking is associated with dislocation climb and the combination of dislocations with prismatic loops originally left behind the dislocations themselves. This causes dislocations to leave the {110} slip plane and lie in irrational planes where they become immobilized due to the strongly anisotropic nature of plasticity in magnesium oxide. It is considered that the immobility of grown-in, aged, and high temperature dislocations is due to a combination of impurity locking, configurational locking, and the reduction of internal stresses. (auth)

34124 (HW-79676) FRACTURE STRESSES OF UO_2–TUNGSTEN CERMETS EVALUATED BY THE DIAMETRAL TENSILE TEST. Interim Report No. 1. E. A. Snajdr (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 1964. Contract AT(45-1)-1350. 39p.

Pneumatically impacted UO_2–tungsten cermets in a composition range from pure tungsten (particle size of 5 microns) to tungsten–50 vol % UO_2 (particle size of 44–75 microns) were tested by the diametral tensile test at room temperature. The tensile fracture stresses decreased from 22,000 to 14,000 psi as the composition varied from pure tungsten to tungsten–50 vol % UO_2. Results of the diametral tensile test are usually lower than the values of the direct pull tensile test and the modulus of rupture test. The average fracture stress of a 20 vol % UO_2–tungsten cermet was 45,690 psi by the modulus of rupture test and 18,400 by the diametral tensile test. Because of the preferential alignment of elongated UO_2 particles during pneumatic impaction, the tensile fracture stresses were orientation-dependent with respect to the pneumatic impaction direction. (auth)

34125 (KFK-220) ZWEI- UND MEHRSTOFFSYSTEME MIT PLUTONIUM. LITERATURUBERSICHT, PHASEN-DIAGRAMME UND DATEN. TEIL II. Pu–Sr BIS Pu–Zr. (Two- and Many-Component Systems with Plutonium. Literature Search, Phase Diagrams, and Data. Part II. Pu–Sr to Pu–Zr). G. Brossmann, M. Kemmerich, and F. Weitzenmiller (Kernforschungszentrum, Karlsruhe, Germany). June 1964. 176p.

Published data on the phase diagrams and properties of the following Pu systems are summarized: Pu–Sr, Pu–Ta, Pu–Te, Pu–Th, Pu–Th–U, Pu–Th–Zr, Pu–Ti, Pu–Tl, Pu–U, Pu–U–Co, Pu–U–Fe, Pu–U–Mn, Pu–U–Ni, Pu–U–Fission Products, Pu–U–Mo, Pu–U–Nb, Pu–U–Ti, Pu–V, Pu–W, Pu–Y, Pu–Zn, and Pu–Zr. In addition the properties of metallic uranium and plutonium are tabulated. 193 references. (J.S.R.)

34126 (NAMC-AML-1550) STUDY OF SIZE EFFECT IN FINE BERYLLIUM WIRE. Paul J. Soltis (Naval Air Material Center. Aeronautical Materials Lab., Philadelphia). Oct. 31, 1962. 4p.

Phase I, the examination and tensile testing of 0.0046-in. dia Be wire in the as-received and pickled conditions, was completed. The wire was found to be uniform in both the as-received and pickled conditions, but the pickling in HNO_3 revealed die marks. The average tensile strength and elongation were determined to be 179,000 psi and 1.72% for as-received wire and 177,000 psi and 1.28% for pickled wire. Most of the observed fractures were brittle. (D.L.C.)

34127 (RT/MET(64)-2) INFLUENCE OF THE RATE OF COOLING FROM THE γ PHASE ON THE STRUCTURES OF DILUTE URANIUM ALLOYS CONTAINING NIOBIUM OR ZIRCONIUM. A. Cabrini, C. Fizzotti, and A. Masperoni (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Apr. 1964. 24p.

Continuous cooling from high temperature of dilute binary uranium–niobium and uranium–zirconium alloys results in three different types of structures which are called, respectively: lamellar, intermediate or bainitic, and martensitic. The metallographic characteristics of these three structures are shown and discussed together with the cooling rates at which they are generated. (auth)

34128 (RTD-TDR-63-4068) DETERMINATION OF MECHANICAL AND THERMOPHYSICAL PROPERTIES OF COATED REFRACTORY AND SUPERALLOY THIN SHEET. D. C. Root and C. H. Savage (North American Aviation, Inc. Space and Information Systems Div., Downey, Calif.). Sept. 1963. Contract AF33(657)-9416. 213p. (AD-426033)

The mechanical properties of foil gages of the D-36 and B-66 columbium and TZM molybdenum alloys were determined in coated and uncoated conditions at temperatures through 2700°F. Test specimens of D-36 and TZM were coated by the Chance Vought Division of Ling-Temco Vought by a two-step, pack-cementation Si–Cr–B process. The B-66 was coated with the Chromizing Corporation's

Durak KA coating. The René 41 and Hastelloy X superalloy foils were evaluated at temperatures through 1900°F without coating. The tests made on these alloys were tensile, notch tensile, fatigue, creep, thermal cycling, thermal shock, dynamic modulus, oxidation, bend, recrystallization, simulated micrometeoroid impact, and microstructural examination. Published mechanical property data on the refractory alloys at elevated temperatures had been obtained by tests in vacuum, but equipment and procedures had not been established for testing the coated refractory alloys in air. It was, therefore, necessary to develop the equipment and procedures to obtain the data required by the contract. This involved numerous problems, principally the accurate measurement of stress, strain, and temperature above 2000°F. The difficulty of making these measurements was compounded by the light gage of the material (2 to 6 mils) and by the presence of protective coatings on the refractory alloys. Two furnaces are described. One was designed for testing bare refractory alloys in vacuum at high temperatures, and the other for testing coated refractory alloys at elevated temperatures. Development of a mechanical extensometer capable of measuring strain in a tensile test at 2700°F is discussed. The vacuum tensile tests of the uncoated refractory alloys indicated that the strength of the B-66 alloy was approximately 5000 psi higher than the TZM and more than 30,000 psi higher than the D-36. With the coatings used in the program, the B-66 was about 15,000 psi stronger than the D-36 at 1800 and 2200°F. The tensile ultimate strength of the coated TZM compared favorably with the coated B-66 at temperatures through 2700°F, but the material was so embrittled that no reliable yield values could be obtained. The results of the thermal cycling, thermal shock, and oxidation tests show that the coatings used in this program would provide only short-time protection for the D-36 and TZM alloys at 2200°F. The oxidation resistance of the B-66 was relatively good for periods up to two hours at 2500°F under cyclic-heating conditions and up to 10 hours at 2700°F in a static atmosphere. As expected from the tensile data, the creep rate of the coated B-66 at 2200°F was significantly lower than that exhibited by the coated D-36 at the same temperature. The ductility of the coated TZM was so low that, with the exception of two tests at 2500°F, only the time-to-rupture data could be obtained. The notch-test results, with the exception of the fatigue-cracked D-36 alloy, showed that the notch strength of the refractory alloys was reduced significantly by coating. Because of the limited number of tests made, these notch-test data should be considered only an indication of the notch strength. The mechanical properties of the superalloy foils were found to be similar to those obtained in heavier gages. The use of uncoated René 41 foil appears to be limited to temperatures below 1800°F because of intergranular oxidation. It should be pointed out that the data obtained in this program for the coated refractory alloys are valid only for the alloys tested when coated in foil gages by the Chance Vought or Chromizing coatings. It is quite possible that other coatings and perhaps more development work on processes for coating foil gages would result in improved mechanical property values. (auth)

34129 (RTD-TDR-63-4102(Suppl.1)) REFRACTORY CERAMICS OF INTEREST IN AEROSPACE STRUCTURAL APPLICATIONS—A MATERIALS SELECTION HANDBOOK. J. F. Lynch, A. Rudnick, D. J. Bowers, F. C. Holden, and W. H. Duckworth (Battelle Memorial Inst., Columbus, Ohio). May 1, 1964. Contract AF33(657)-8326. 76p. (AD-600588)

Presented are additional refractory-ceramic property data to supplement those published in the first edition of the Materials Selection Handbook, issued in October, 1963, as RTD-TDR-63-4102. The materials covered are nonmetallic inorganic crystalline materials with melting points above 2730°F (1500°C), including intermetallic compounds and excluding glass, carbon, and graphite. The data are from literature published in 1961 and 1962. (auth)

34130 (TID-8540(p.331-410)) METALLIC FUELS. Stanley F. Pugh and Benjamin R. Butcher (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

The present state of knowledge of the physical metallurgy and in-pile behavior of metallic fuel materials for power reactors is described. Uranium and very dilute uranium alloys, i.e., alloys with less than 0.25 wt % of alloying elements and impurities, are discussed. The alloying elements, Fe, Si, Al, and Cr, were originally added to achieve grain refinement by some form of beta heat treatment; but, in power reactors operating in the high alpha range, some alloying elements have been found to affect other properties such as creep, recrystallization, and swelling. Uranium–molybdenum, U–Zr, U–Nb, and U–Al alloys, and Th-metal fuels are considered. A bibliography of 213 references is presented. (R.E.U.)

34131 (TID-20849) PHASE EQUILIBRIA AND SPECIFIC VOLUMES OF LIQUID METALS AND ALLOYS. Report No. III. Frank A. Kanda and Douglas V. Keller (Syracuse Univ., N. Y. Research Inst.). May 1964. Contract AT(30-1)-2731. 36p.

The phase diagram of the Ca–Li system is given and discussed. The effects of hydrogen impurity and nonequilibrium conditions are discussed. The results indicate that $CaLi_2$ is the only compound formed. The type of compounds formed in several alkali–alkaline earth metal system is discussed in terms of radius ratio and crystal lattice type of the pure metals. An automatic densitometer was constructed for dynamic density measurements on molten metals in vacuum. Density isotherms are used to study the immiscibility boundary in the isoamyl alcohol–glycerol system and compound formation in the phenol–water and Hg–Tl systems. Density measurements are also reported for liquid Bi and Tl. The modified high-temperature calorimeter and current DTA studies on the Al–Ba and Al–Sr systems are described. (D.L.C.)

34132 (UCRL-11323) PLASTIC DEFORMATION OF MAGNESIUM OXIDE SINGLE CRYSTALS AT ELEVATED TEMPERATURES (thesis). Stephen M. Copley (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1, 1964. Contract W-7405-eng-48. 107p.

Carefully controlled stress-strain measurements have been obtained for MgO single crystals compressed at a constant stress rate, with ⟨100⟩ and ⟨111⟩ stress axes, at temperatures ranging from 1000 to 1600°C. These have been correlated with etch pit and stress birefringence studies of the distribution of dislocations in single crystals at various stages of deformation. Similar correlations have also been made in the temperature range 26 to 1000°C, where the stress-strain behavior of MgO has already been fairly well established by previous investigations. A general discussion of the complications which arises in making and interpreting stress-strain measurements in compression is given. Specimens with ⟨100⟩ stress axes deform plastically by slip on $\{110\}\langle 1\bar{1}0\rangle$ slip systems. At room temperature, the shape of the stress-strain curve is determined by the dislocation mobility and the number of slip bands

formed. Dislocations only move in the undeformed regions at slip band edges. Strain hardening results from slip band overlap. Between 26 and 1000°C, the dislocation mobility increases with increasing temperature, thus causing the yield stress to decrease. The etch pit density in slip bands formed at 500°C is less than at room temperature, while the total shear strain is about the same. At 1000°C slip bands still form; however, dislocations were also found to be distributed throughout the volume of the crystal. This effect was attributed to the initial of slip by grown-in dislocations. The slope of the stress-strain curve, after yielding, is about five times greater at 1000°C than at room temperature because there are no longer undeformed regions in which dislocations can move. Above 1100°C, the yield stress decreases slowly with increasing temperature, and the strain rate becomes much less stress sensitive. The strain-hardening rate decreases rapidly owing to the annealing out of thermally unstable dislocation damage such as dislocation dipoles. At 1300°C, polygonalization walls, and dislocation boundaries formed by dislocations lying on oblique slip planes, obstruct dislocation movement. Above 1400°C, polygonalization walls were no longer observed to form. Specimens with ⟨111⟩ stress axes deform plastically by slip on the {100} ⟨01$\bar{1}$⟩ slip systems. The ratio of yield stresses of ⟨111⟩ specimens to ⟨100⟩ specimens decreased rapidly from 1000 to 1600°C. Strain hardening for ⟨111⟩ specimens was much higher than for 100 specimens: The Burgers vectors of the active slip systems lie at 60 deg (or 120 deg) to each other and thus there are long range stresses between intersecting dislocations. (auth)

34133 (UCRL-11388) THE EFFECT OF PLASTIC STRAINING AND CYCLIC HEATING ON THE MARTENSITIC TRANSFORMATION IN AN ALLOY STEEL (thesis). David T. Dickson (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). June 1964. Contract W-7405-eng-48. 52p.

A thermal-mechanical process was developed to produce a fine alloy carbide dispersion in a high carbon steel (0.86C, 9.78Cr). A dislocation grid was first produced by warm-working the austenite to produce a dislocation network. Alloy carbides were precipitated on the network during the warm-working operation. The initial martensite plates were limited in size since they were confined to the carbide-dislocation grid. The remaining austenite in this alloy was then completely converted to martensite by a series of alternate elevated and progressively decreasing cryogenic temperature treatments. The result was a fine dispersion of alloy carbides in a matrix of fine grained hard (Rc 65) martensite. (auth)

34134 (UCRL-11417) LITHIUM ALLOYING AND DISLOCATION MECHANISMS FOR PRISMATIC SLIP IN MAGNESIUM (thesis). Aziz Ahmadieh (California. Univ., Berkeley. Lawrence Radiation Lab.). May 18, 1964. Contract W-7405-eng-48. 61p.

An investigation was made to determine the role of lithium alloying on the dislocation rate controlling mechanisms of magnesium oriented for (10$\bar{1}$0) [1$\bar{2}$10] prismatic slip using three alloys, namely, 12.5, 10.8, and 6.8 at.% Li–Mg. Whereas prismatic slip was preceded by twinning and fracturing at temperatures below 450°K in pure magnesium, the alloy containing 6.8 at.% Li was ductile at temperatures as low as 200°K. The higher Li alloys showed more than 20% shear strain at 4.2°K and finally fractured on the prismatic planes upon initiation of duplex slip. The data revealed that the alloys have a critical resolved shear stress lower than that of pure Mg showing that the Li–Mg alloys provide an exception to one of the usual trends of alloying, namely, that solid solutions are stronger than the pure parent metals. This decrease in the flow stress is enhanced by increasing the lithium content. Whereas the flow stress increased only slightly with decrease in test temperature below 400 and 370°K for the 12.5 and 10.8 at.% Li alloys respectively, a rapid increase in the flow stress was obtained at temperatures below room temperature in all three alloys. The effect of both temperature and strain rate on the flow stress in the low temperature range could be completely rationalized in terms of the Peierls mechanism when the deformation is controlled by the rate of nucleation of pairs of kinks. Neither the Peierls mechanism nor the dislocation intersection mechanism can account for the data obtained from the 6.8 at.% Li alloy at high temperatures. However, the data are in excellent agreement with the dictates of Friedel's theory for cross-slip to the prismatic plane. The separation of the dislocation partials on the basal plane and their constriction energy are lower in Li–Mg alloys than in pure Mg suggesting the increase of stacking fault energy with the addition of lithium. (auth)

34135 (AI-Trans-53) THE INFLUENCE OF VACANCIES ON DECOMPOSITION KINETICS DURING ZONE FORMATION IN ALUMINUM–MAGNESIUM ALLOYS. K. Detert and L. Thomas. Translated by Anthony Cornell (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.), from Acta Met., 12: 431-41 (1964). 22p.

The change in electrical resistivity during aging of aluminum–magnesium alloys was measured after quenching. The quenching temperatures were varied between 150 and 420°C, and the aging temperatures between –30 and +50°C. An interrupted quench was also performed, in which the specimens were held for different periods at temperatures between 50 and 70°C before quenching down to the aging temperature of –15°C. The experimental parameters changed the rate of resistivity increase during aging, indicating zone formation in the lattice. It is shown that the quantity $\Delta R/\Delta R_{max}$ may be assumed proportional to the reaction product y for the decomposition. The curves of the form $y = 1 - \exp(-\sqrt{mt})$, which were found experimentally for quenching temperatures between 150 and 300°C, and for aging temperatures between –30 and +10°C, are interpreted by the growth model of thin plate-shaped decomposition zones. The measured temperature dependences of the factor m describe the dependences of the diffusion coefficient of magnesium in aluminum determined by the actual vacancy concentration and the probability of diffusion of the magnesium atoms with vacancies. The quantity $Q_1 = 0.74$ ev, obtained from the quenching temperature dependence, may be assigned to the energy of formation of vacancies in Al–Mg alloys, while the quantity $Q_2 = 0.51$ ev, measured from the variation in the aging temperature, may be assigned to the activation energy for the diffusion of magnesium atoms. The dependence of the intermediate holding time provides information on the life of vacancies in Al–Mg. The results permit the conclusion that no considerable association of vacancies and Mg atoms occurs, and that the migration of Mg atoms during zone formation and the annealing of excess atoms take place simultaneously. (auth)

34136 ON THE CRYSTAL STRUCTURE OF $NbTe_4$. Kari Selte and Arne Kjekshus (Universitetet, Oslo). Acta Chem. Scand., 18: 690-6(1964).

One of the phases in the niobium-tellurium system was identified as $NbTe_4$. This compound crystallizes tetragonally with $a = 2 \times 6.499$ Å; $c = 3 \times 6.837$ Å; $c/a = 3/2 \times 1.052$. The pycnometric density is 6.88 g cm^{-3} at 25°C.

There are 12 × 2 formula units per unit cell. For the subcell a′ = 6.499 Å; c′ = 6.837 Å, and the space group is $P4/mcc$ and the atomic positions are: 2 Nb in (a) ± (0,0,¼); and 8 Te in (m) ± (x,y,0; $\bar{y}$,x,0; $\bar{x}$,y,½; y,x,½), with x = 0.1425, y = 0.3316. (auth)

34137 ON THE STRUCTURAL PROPERTIES OF THE $Nb_{1+x}Se_2$ PHASE. Kari Selte and Arne Kjekshus (Universitetet, Oslo). Acta Chem. Scand., 18: 697-706(1964).

The $Nb_{1+x}Se_2$ phase has a homogeneity range within the limits 60.8 (61.5 for samples quenched from 1000°C) and 66.67 atomic % Se. The structure is hexagonal and the lattice constants vary between the limits $Nb_{1.29}Se_2$: a = 3.450 Å, c = 13.02 Å, c/a = 3.774 ($Nb_{1.25}Se_2$: a = 3.425 Å, c = 12.92 Å, c/a = 3.743 for samples quenched from 1000°C); and $Nb_{1.00}Se_2$: a = 3.446 Å, c = 12.55 Å, c/a = 3.643. Between ~63 and ~65.5 atomic % Se the existence of a superstructure was observed. As indicated by the formula $Nb_{1+x}Se_2$ the solid solution takes place by addition of niobium atoms as the niobium content increases from $Nb_{1.00}Se_2$ to $Nb_{1.29}Se_2$. The crystal structure is of the NbS_2 (H) type. In terms of the space group $P6_3/mmc$ the unit cell contains 2 + 2x Nb and 4 Se in the positions: 2 Nb in (b) ± (0,0,¼); 2x Nb in (a) 0,0,0; 0,0,½ and 4 Se in (f) ± (⅓,⅔,z; ⅓,⅔,½ − z) with z = ⅛. (auth)

34138 QUENCHING STUDY ON TUNGSTEN WITH THE HELP OF HELIUM II. H. Schultz (OSRAM — Studiengesellschaft, Augsburg, Ger.). Acta Met., 12: 761-3(June 1964). (In German)

Results on the study of the quenching behavior of W using He(II) are reported. The Rinderer method was used for the investigation to prevent interferences by H, O, N, and C. The results show that a sufficient quenching velocity is attained when the wires are quenched in the He cryostat 1 and 2 cm over the He(II) bath. There is an exponential dependence of the quenching-induced supplementary resistance on the reciprocal absolute temperature. The mean value obtained for the formation energy of vacancies was 3.30 ± 0.1 ev. The activation energy for self-diffusion was 1.93 ± 0.3 ev. The entropy $S_B/k = 1.4$ (k is the Boltzmann constant) and the vacancy concentration at the melting point is 1.1×10^{-4}. (J.S.R.)

34139 ON THE GRAIN GROWTH OF ZIRCONIUM, ZIRCALOY-2, AND TITANIUM IN THE HIGH-TEMPERATURE PHASE. H. G. Feller (Technische Universitat, Berlin). Acta Met., 12: 964-6(Aug. 1964). (In German)

Results of studies on the sample thickness effect in Zr, Zircaloy-2, and Ti during glowing slightly over the transformation temperature in the high-temperature phase and the effects of grain growth on the dimensions of the sample are reported. The curing of vacancies on the surface and the mean free path of vacancies at the glow temperature were estimated. Mechanisms for the surface phenomena are discussed. (J.S.R.)

34140 DEFORMATION AND FRACTURE OF ROLLED BERYLLIUM OF VARIOUS PURITIES. V. M. Amononenko, V. M. Azhazha, V. E. Ivanov, G. F. Tikhinskii, and V. A. Finkel'. At. Energ. (USSR), 16: 426-32(May 1964). (In Russian)

A study was made of the plastic deformation and character of fracture at 20 to 800°C of beryllium strips of purity 99.0 and 99.6%, prepared by rolling and casting in a vacuum. It was established that the basic mechanism of plastic deformation is slip in the $(10\bar{1}0)$ $[11\bar{2}0]$ system; fracture occurs either at the plane of conjunction (at low temperatures) or at the grain boundaries (at high temperatures). Impurities show an influence on the magnitude of plastic deformation and on the character of fracture. The creep boundary in high purity beryllium in the temperature region investigated is several times lower than the boundary in metal of purity 99.0%. The metal of technical purity is a strengthened alloy. (tr-auth)

34141 BERYLLIUM AS A STRUCTURAL MATERIAL. Webster Hodge. Battelle Tech. Rev., 13: No. 8, 12-16 (Aug. 1964).

Available Be forms and their properties, and structural and nonstructural uses of Be are discussed. Special attention is given to structural uses of Be in space vehicles. Other possible applications of Be in space technology are also discussed. (P.C.H.)

34142 THERMOELECTRIC PROPERTIES OF CUBIC URANIUM MONOCOMPOUNDS. I. H. Warren and C. E. Price (Univ. of British Columbia, Vancouver). Can. Met. Quart., 3: 183-96(Apr.-June 1964).

Sodium chloride type monocompounds of U with C, N, P, As, Sb, S, and Se were prepared. Their thermoelectric powers (α) and electrical conductivities (σ) were measured up to approximately 1000°C. Room-temperature thermal-conductivity (K) data were also obtained. (auth)

34143 MEASUREMENT OF THE THERMAL CONDUCTIVITY AND THE THERMOELECTRIC FORCE BETWEEN 4 AND 40°K OF URANIUM–MOLYBDENUM ALLOYS IN THE γ PHASE. Pierre Haen and Louis Weil (Centre de Recherches sur les Très Basses Temperatures, Grenoble, France). Compt. Rend., 258: 6130-3(June 22, 1964). (In French)

It was experimentally verified that, for uranium, the thermal conductivity and, for uranium and U–Mo alloys at 8 and 14.6%, the electrical conductivity is in agreement with previous measurements. The absolute thermoelectric force was measured from 4 to 17°K by reference to a superconductor. For the two alloys, it was less than one-tenth that predicted by the theory of Blatt. (tr-auth)

34144 A URANIUM OXYCARBIDE–DIOXIDE EUTECTIC. Pierre-Lazare Blum and Jean-Pierre Morlevat (CEN, Grenoble, France). Compt. Rend., 258: 6151-3 (June 22, 1964). (In French)

The existence of a dioxide–oxycarbide eutectic in the ternary uranium dioxide–uranium monocarbide–uranium system was established. The temperature at the end of solidification was found to be equal to that of the uranium–uranium carbide eutectic. (J.S.R.)

34145 CRYSTAL STRUCTURE OF THE β-PHASE OF THE SYSTEM Nb–Co AND SOLUBILITY OF SILICON IN IT. Yu. B. Kuzma, A. K. Shuryn (Shurin), H. (G.) P. Dmitrieva, and E. Y. (I.) Hladyshevskyi (Gladishevskii) (Moscow State Univ. and Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. SSR, No. 5, 600-3(1964). (In Ukrainian)

The high-temperature β-phase of the system Nb–Co with a structure of the $MgZn_2$ type (space group $P6_3/mmc$–D^4_{6h}, a = 4.834 ± 0.002 Å, c = 7.853 ± 0.004 Å, c/a = 1.624) may be stabilized by dissolving silicon up to a content of 25 at. % Si. (auth)

34146 REACTION DIFFUSION IN METAL-COMPLEX GAS SYSTEMS. VII. MOLYBDENUM–SILICON–BORON. V. N. Konev, A. F. Nesterov, and I. P. Glazkova (Ural State Univ., USSR). Fix. Metal. i Metalloved., 16: 86-90 (1963). (In Russian)

Diffusion reaction of Mo–B–Si systems in a BCl_3 + $SiCl_4$ + H_2 mixture formed the boride base compound Mo_2B_5

at 1000°C and α–MoB and Mo_2B_5 above 1000°C. Participation of silicon in the diffusion zone increased the activation energy. (tr-auth)

34147 ANISOTROPIC PROPERTIES OF SCANDIUM MONOCRYSTALS. O. P. Naumkin, V. F. Terekhova, and E. M. Savitskii (Baikov Inst. of Metallurgy, USSR). Fiz. Metal. i Metalloved., 16: 663-8(1963). (In Russian)

Studies of electrical, mechanical, and magnetic properties of Sc monocrystal showed anisotropy along the basic directions of the hexagonal lattice. The microhardness along the basic plane (0001) is 210 kg/mm^2 and along the prism (1010), 102 kg/mm^2. The magnitude of anisotropic paramagnetic susceptibility at room temperature was about 30%. (R.V.J.)

34148 EFFECTS OF COLD HARDENING ON DISINTEGRATION OF SATURATED SOLID SOLUTION OF NEODYMIUM IN MAGNESIUM. L. L. Rokhlin (Baikov Inst. of Metallurgy, USSR). Fiz. Metal. i Metalloved., 16: 703-9 (1963). (In Russian)

Measurements of electric conductivity showed that cold hardening increased disintegration in solid-solution Nd-Mg. Plastic deformation of the crystal lattice induced by the hardening was very stable and was retained until almost all the Nd is separated from the solid solution. The presence of a large amount of dispersed particles from the second phase increased the recrystallization temperature to 450°C. The microstructure of Mg with 3.38% Nd tempered at 535°C and annealed for 24 hr at 200 to 500°C was studied. (tr-auth)

34149 REACTIONS OF MOLYBDENUM DISILICIDE WITH BERYLLIUM. L. F. Verkhorobin, P. I. Glushko, V. I. Dorokhov, and N. N. Matyushenko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Fiz. Metal. i Metalloved., 16: 751-3(1963). (In Russian)

X-ray diffraction analysis showed that at 900 to 1100°C beryllium reduced $MoSi_2$, forming $MoBe_{12}$ and $MoBe_{22}$. A ternary compound $Mo(Si_{0.9}Be_{0.1})_2$ of the $CrSi_2$ type with lattice periods a = 4.61 and c = 6.45 Å was found in the system. Oxidation of pure $MoSi_2$ in air at 1000 to 1200° is much slower than the oxidation of $MoSi_2$ annealed with beryllium powder. (R.V.J.)

34150 MOTION OF DISLOCATIONS IN A DEFORMED MOLYBDENUM CRYSTAL. Yu. I. Demkin (Central Scientific Research Inst. of Ferrous Metallurgy, [Academy of Sciences,] USSR). Fiz. Metal. i Metalloved., 17: 768-9 (May 1964).

A study was made on the change, induced by electrolytic etching, in the dislocation structure of a molybdenum single crystal that was first subjected to deformation by a mechanical load. Two etching procedures were used, and photomicrographs are given illustrating the effects of each treatment on dislocations and their motion. It was found that preliminary plastic deformation not only does not hinder the motion of dislocations during the etching process without the application of an external load, but, on the contrary, increases the tendency toward such motion. A predominant factor is the effect of internal strains present in the material, not the presence of dislocations as stacking faults. The role of etching in inducing the motion of dislocations remains unclear, but the results conducted show that the prime cause of such motion is the instability of the internal structure of the crystals. (OTS)

34151 LESS COMMON METALS FOR PROCESS EQUIPMENT. E. M. Sherwood. Ind. Eng. Chem., 56: No. 8, 59-64(Aug. 1964).

The technology and applications for process equipment of beryllium, chromium, molybdenum, niobium, rhenium, tantalum, tungsten, and zirconium are reviewed. The 414 references are listed by metal and cross-listed to the following topics: reviews, extraction, refining, consolidation, melting, working and forming, cutting, joining, structure and properties, corrosion, oxidation, coatings, alloys, and applications. (M.C.G.)

34152 STUDY OF THE LIMITING VALUES FOR ACTIVATION OF CREEP IN TITANIUM–ZIRCONIUM ALLOYS. K. A. Osipov and A. L. Sotnichenko. Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 10: 27-31(1963).

The results of a study on the creep of polycrystalline alloys in the titanium–zirconium system in the state of α-modification are reported. The study involved alloys melted in a vacuum arc furnace with a consumable electrode. In order to obtain homogeneous alloys, each ingot was remelted two to three times. Alloys containing 25.1, 50, and 75.7 at. % Zr were melted. The ingots obtained, weighing 5 kg, were used to prepare rods 10 mm in diameter by hot forming. Prior to forming the blanks were wrapped in copper foil (0.2 mm thick) and lubricated with colloidal graphite. The samples to be creep tested were vacuum annealed (1×10^{-4} mm Hg) at 800°C for 24 hr, then the temperature was lowered to 450°C (for the alloy with 50% Zr) and to 550°C (for the alloys with 25.1 and 75.7 at. % Zr) and the samples were held at these temperatures for 168 hours. The samples were tested for creep at a pressure of 1×10^{-4} mm Hg between 25 and 200°C with a VPN-52 tester at applied stresses of 30, 35, 40, 45, 50, 55, 60, 65, and 70 kg/mm^2. It was found that the activation energy for these alloys is a decreasing function of stress as the applied stress is changed from 40 to 60 kg/mm^2. As stress is increased further, ΔH remains practically constant, i.e., a limiting activation energy value is reached which is equal to 8.1, 6.9, and 8.6 kcal/mole for alloys of titanium with 25, 50, and 75.7 at. % Zr, respectively. For maximum stress values, at which the limiting value of the activation energy is observed, experimental values were determined by the method of least squares. At stresses above 70 kg/mm^2, in the case of titanium alloys with 25 and 50 at. % Zr and a stress above 60 kg/mm^2, rapid failure of the samples occurred, which does not permit recording of creep curves. Thus, limiting values of the activation energy of steady creep were obtained at the maximum permissible stresses for all the studied alloys of the Ti–Zr system as well as pure titanium and zirconium. It was found that the structure factor changes very little at these stresses. An analysis of the results led to the conclusion that in the titanium–zirconium alloys, which are in the state of the α-modification, the nature of the activated state acted upon by large applied stresses during creep does indeed correspond to a local polymorphic transformation. (TCO)

34153 SOME FEATURES OF THE STRENGTH AND DIFFUSION CHARACTERISTICS OF ZIRCONIUM. G. B. Fedorov. Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 10: 46-52(1963).

On the basis of an analysis of experimental results, equations were derived for the temperature dependence of the coefficients of self-diffusion of stabilized zirconium (in cm^2/sec): for α-zirconium, $D = 10^{-5} \exp(-40{,}000/RT)$; and for β-zirconium, $D = 2 \times 10^{-4} \exp(-40{,}000/RT)$. It was found that zirconium has a large number of defects in the unstabilized state. It is suggested that a cyclic mechanism

of diffusion occurs in zirconium and that it becomes complicated by the large number of vacancies in the unstabilized metal. (OTS)

34154 THE RATE OF COMPONENT EVAPORATION DURING THERMAL DISSOCIATION OF YTTRIUM AND LANTHANUM BERYLLIDES. V. M. Amonenko, A. A. Kruglykh, V. S. Pavlov, and G. F. Tikhinskii. Izv. Akad. Nauk SSSR, Met. i Gorn. Delo, No. 3, 158-60(May-June 1964). (In Russian)

The rate of beryllium evaporation during thermal dissociation of yttrium beryllide (YBe_{13}) and lanthanum beryllide ($LaBe_{13}$) was studied at 1040 to 1290°C. The intermetallics dissociate at <1050°C. The equilibrium vapor pressure of Be during the dissociation was estimated. The heats of evaporation for YBe_{13} and $LaBe_{13}$ were 75.0 and 75.8 kcal/mole, respectively. (R.V.J.)

34155 SOME PROPERTIES OF HIGH-PURITY ZIRCONIUM DIOXIDE. G. P. Kalliga and L. A. Lyutsareva. Izv. Vysshykh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 7: 106-10(1964).

Sinterability and some high-temperature physicomechanical characteristics of sintered, stabilized, 99.5%-pure zirconium dioxide were studied by x-ray, dilatometric, and microscopic methods. The high-temperature characteristics of the high-purity zirconia were found to be far superior to those of materials based on technical grade zirconia. The best characteristics at 1700–1750°C were obtained with high-purity zirconia stabilized with 10 mol % calcium or magnesium oxide. However, better sinterability (higher density) at temperatures below 1700°C was achieved with magnesium oxide than with the same amount of calcium oxide admixture. Titanium dioxide and alumina admixtures to a high-purity zirconia stabilized with calcium oxide improve sinterability but decrease the refractory properties of the material, especially in the case of alumina admixture. (OTS)

34156 MAGNETIC CHARACTERISTICS OF $CeFe_2$. John Farrell and W. E. Wallace (Univ. of Pittsburgh). J. Chem. Phys., 41: 1524-5(Sept. 1, 1964).

Magnetic properties of the Laves phase compound $CeFe_2$ are reported. The results obtained were in keeping with the behavior expected for $CeFe_2$. It is noted that $CeFe_2$ is magnetically soft, and its magnetization-temperature behavior conforms to the molecular-field theory rather well. The aggregate of all evidence available suggests rather strongly that $CeFe_2$ is a simple ferromagnet with Ce present as a nonmagnetic entity, and hence existing in the quadripositive state. The lines of evidence that lead to this conclusion are discussed. (P.C.H.)

34157 SUPERCONDUCTING THIN FILMS OF NIOBIUM, TANTALUM, TANTALUM NITRIDE, TANTALUM CARBIDE, AND NIOBIUM NITRIDE. D. Gertenberg and P. M. Hall (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc., 111: 936-42(Aug. 1964).

Tantalum and niobium films were examined with respect to their superconducting properties. The films were deposited both by sputtering in a high vacuum station and by electron beam evaporation in an ultra high vacuum system. The transition temperatures of sputtered films were lower than the respective values of the pure bulk metals presumably due to interstitial impurities. Reactively sputtered TaC, TaN, and NbN films were found to be superconducting, but no superconducting transition was found for Ta_2N films. Bulk Ta_2N and TaN have no superconducting transition down to 1.5°K, and the appearance of a transition in the TaN film is probably related to a new fcc crystal structure of the TaN films. Electron beam evaporated tantalum and niobium films of a few thousand angstrom thickness have superconducting transition temperatures of 4.3 and 9.1°K, respectively, which are comparable to those of the pure bulk metals of 4.5 and 9.5°K. The purest evaporated tantalum and niobium films, however, show critical fields that are an order of magnitude higher than bulk values, probably due to imperfections and strain. (auth)

34158 ELECTRICAL PROPERTIES OF SELECTED RARE EARTH COMPOUNDS AND ALLOYS. F. J. Reid, L. K. Matson, J. F. Miller, and R. C. Himes (Battelle Memorial Inst., Columbus, Ohio). J. Electrochem. Soc., 111: 943-50(Aug. 1964).

Rare earth elements, neodymium, gadolinium, samarium, cerium, erbium, and ytterbium, in compounds and alloys with Group V elements arsenic and antimony and Group VI elements selenium and tellurium were studied. The properties discussed include carrier concentration and carrier mobility, electrical and thermal conductivity, and thermoelectric power as functions of temperature and composition. Several suggested applications utilizing these materials are given. (auth)

34159 DOPING OF ALKALINE EARTH HALIDE SINGLE CRYSTALS. P. F. Weller and J. E. Scardefield (International Business Machines Corp., Yorktown Heights, N. Y.). J. Electrochem. Soc., 111: 1009-11(Aug. 1964).

Studies were made on the growth of doped, alkaline earth halide single crystals. The results showed that when doping with divalent rare earths, easily reduced species such as Pb^{2+} should be absent. U^{3+} doping is obtained from uranium metal by using long melt times along with the PbFe oxidizing agent. If U^{3+} is added directly to the host, as UF_3 for example, PbF_2 should not be used. Other ionic host materials for divalent rare earths and/or U^{3+} can be chosen or eliminated on the basis of an oxidation potential argument. For example, alkaline earth and alkali metal halides as well as La, Y, and Sc halides can be doped with divalent rare earths, whereas halides of In, Tl, Bi, Pb, or Cd, in general, cannot. (P.C.H.)

34160 THE CONSTITUTION OF YTTRIUM–CERIUM AND YTTRIUM–LANTHANUM ALLOYS, WITH SPECIAL REFERENCE TO LATTICE SPACINGS. I. R. Harris and G. V. Raynor (Univ. of Birmingham, Eng.). J. Less-Common Metals, 7: 1-10(July 1964).

Lattice spacing measurements were made for a selection of alloys in the yttrium–cerium system, and for pure yttrium and cerium. The curve of atomic volume against composition for the yttrium-rich solid solution shows a positive deviation from the line joining the atomic volumes of the components, and the apparent atomic diameter of cerium in solid solution is 3.689 kX, as compared with 3.642 kX for γ cerium. This expansion of the cerium atoms in solid solution contrasts with the contraction observed when in solid solution in thorium and zirconium. The results are briefly discussed, in terms of a tendency for cerium to adopt the same valency as that of the solvent under conditions such that the strain energy of alloy formation is small or easily accommodated. (auth)

34161 THE LATTICE SPACINGS OF THORIUM–CERIUM ALLOYS AT ELEVATED TEMPERATURES. I. R. Harris and G. V. Raynor (Univ. of Birmingham, Eng.). J. Less-Common Metals, 7: 11-16(July 1964).

Experiments were performed on the variation of lattice spacings with temperature, in the range 25–460°C, for thorium and a thorium–cerium alloy containing 20 at. % cerium. The results show that at 194°C the minimum in

the room temperature lattice spacing/composition curve is eliminated; the curve at 194°C is horizontal from 0 to 20 at. % cerium. The results are discussed, together with those obtained at sub-zero temperatures, and it is suggested that the electronic constitution of cerium in solid solution in the thorium-rich matrix may be variable with temperature. (auth)

34162 THE HIGH-TEMPERATURE RESISTIVITIES OF DYSPROSIUM, HOLMIUM, AND ERBIUM. C. E. Habermann and A. H. Daane (Ames Lab., Ames, Iowa). J. Less-Common Metals, 7: 31-6(July 1964).

The electrical resistivities of dysprosium, holmium, and erbium were investigated as a function of temperature over the range from room temperature to near the melting points of the metals. Dysprosium exhibits a discontinous change in the resistivity at a transformation temperature of 1375°C, but holmium and erbium show only a change of slope and a small amount of hysteresis in their respective resistivity curves at high temperatures. (auth)

34163 THE CONSTITUTION DIAGRAM OF THE NIOBIUM–HAFNIUM SYSTEM. A. Taylor and N. J. Doyle (Westinghouse Research Labs., Pittsburgh). J. Less-Common Metals, 7: 37-53(July 1964).

The niobium–hafnium binary system was studied using a combination of x-ray diffraction and microscopical techniques along with hardness and melting point determinations. The phase diagram is closely analogous to those of the niobium–titanium and niobium–zirconium systems. It comprises two single-phase fields, namely, that of the body-centered cubic Nb primary phase, which forms an unbroken series of solid solutions with β–Hf above 1950°C, and the narrow hexagonal close-packed α–Hf phase, which exists below 1950°C and forms via a martensitic transformation from β–Hf. The $\beta/\alpha + \beta$ phase boundary stretches from pure Hf at 1950°C across the diagram until at 1000°C only 34 at. % Hf is in solution, whereas the $\alpha/\alpha + \beta$ boundary is almost vertical, α–Hf taking, at most, 2–2.5 at. % Nb into solid solution, the precise amount being uncertain owing to the Zr content of the Hf (approx. 4.41 at. % Zr). (auth)

34164 ELECTRICAL RESISTIVITY OF α–URANIUM FROM 2° TO 300°K. Sigurds Arajs and R. V. Colvin (U. S. Steel Corp. Research Center, Monroeville, Penna.). J. Less-Common Metals, 7: 54-66(July 1964).

Electrical resistivities of three α–uranium samples were studied in detail between approximately 2 and 300°K. The residual resistivities of these samples are 0.762, 0.955, and 4.99 $\mu\Omega$ cm. The samples of the lowest residual resistivity clearly exhibits an anomaly at about 50°K. This resistivity anomaly appears to be very sensitive to the previous thermal history of the sample and to the direction and rate of the temperature changes used to make the resistivity measurements. Detailed discussion of the experimental observations is presented. The resistivity anomaly to a smaller extent is also observable in the other uranium samples. The anomaly is not of the standard type to be associated with the antiferromagnetic-paramagnetic transformation. The reduced Ziman resistivities at 300°K were calculated for thorium, uranium, neptunium, and plutonium. (auth)

34165 PHASE EQUILIBRIA AND CRYSTALLOGRAPHY FOR THE NIOBIUM–TIN SYSTEM. Thomas G. Ellis and Harley A. Wilhelm (Ames Lab., Ames, Iowa). J. Less-Common Metals, 7: 67-83(July 1964). (IS-666)

On the basis of data gathered by means of x-ray diffraction, chemical analysis, and metallographical techniques, a constitution diagram for the niobium–tin binary alloy system is proposed. The equilibrium solubility of niobium in liquid tin varies from 0.027 wt % niobium at 580°C to 0.198 wt % niobium at 1000°C. The equilibrium solubility of tin in niobium varies from approximately 2.5 wt % tin at 550°C to approximately 3.0 wt % tin at 1000°C. In addition to Nb_3Sn, two other intermetallic compounds, both having orthorhombic crystal structures, were found in the alloys of the system. The two orthorhombic compounds are assumed to be Nb_3Sn_2 and Nb_2Sn_3. All the compounds in the system were observed to decompose peritectically: Nb_3Sn at 2130 ± 25°C, Nb_3Sn_2 at 915 ± 5°C, and Nb_2Sn_3 at 820 ± 3°C. The Nb_3Sn_2 compound has a body-centered orthorhombic crystal structure with lattice parameters of 5.656 ± 0.002, 9.199 ± 0.003, and 16.843 ± 0.004 Å. The number of possible space groups for the Nb_3Sn_2 was reduced to four, D_2^8–I222, D_2^9–$2_12_12_1$, D_{2h}^{25}–Immm and C_{2v}^{20}–Imm2. The Nb_2Sn_3 has a face-centered orthorhombic crystal structure with lattice parameters of 5.655 ± 0.001, 9.860 ± 0.001, and 19.152 ± 0.004 Å. The space group for the Nb_2Sn_3 is D_{2h}^{24}–Fddd. (auth)

34166 THERMAL STRESS EVALUATION OF CERAMIC FUEL ELEMENTS. B. A. Chandler and J. E. McConnelee (General Electric Co., Cincinnati). J. Nucl. Mater., 11: 273-301(Apr. 1964).

The procedures used and the correlations obtained in a combined analytical-experimental evaluation of the thermal stress resistance of beryllium-oxide fuel elements are discussed in detail. The calculated residual thermal stress levels in fuel elements that failed during tests relative to the room temperature modulus of rupture of the fuel element material is of particular interest. The experimental program described includes both nuclear and non-nuclear tests. The analysis used to obtain the calculated thermal stress is described in the appendix, and includes the effects due to an hexagonal outer surface, end effects, and the effect of a clad at the bore of the tube. It was concluded that analytical stress analysis in conjunction with extensive non-nuclear bench type testing and limited nuclear testing provides a sound basis for evaluating the thermal stress resistance of ceramic fuel elements. (auth)

34167 ORIENTATION IN EXTRUDED BeO. L. H. Sjodahl (General Electric Co., Cincinnati). J. Nucl. Mater., 11: 302-9(Apr. 1964).

Characteristic particle shape in three types of BeO powder used for extrusion was found to control the amount and direction of preferred orientation in extruded rods. The enhancement of orientation during grain growth was demonstrated. A quantitative measurement of orientation distribution was used with thermal expansion and Young's modulus measurements on polycrystalline rods of varying orientation to resolve these properties along the principal crystallographic axes. (auth)

34168 THE OBSERVATION AND ANALYSIS OF SLIP DISLOCATIONS AND PRISMATIC LOOPS IN BERYLLIUM. G. P. Walters, C. M. van der Walt, and M. J. Makin (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 11: 335-40(Apr. 1964).

A search was made, using the transmission electron microscope technique, for dislocations in Be with non-basal Burgers vectors. The dislocations were found and furthermore were observed to move in the microscope, thus proving that at least some non-basal slip is possible at room temperature in beryllium. Analysis of nodes formed by dislocation interactions suggests that the non-basal vector is $\frac{1}{3}\langle 11\bar{2}3\rangle$. Dislocation loops lying pre-

dominantly on $\{11\bar{2}0\}$ planes with normal $\frac{1}{3}\langle 11\bar{2}0\rangle$ vectors were observed in quenched and irradiated beryllium. (P.C.H.)

34169 HYDROGEN EMBRITTLEMENT OF SOME ZIRCONIUM ALLOYS. W. H. Erickson and D. Hardie (Univ. of Newcastle upon Tyne, Eng.). J. Nucl. Mater., 11: 341-3(Apr. 1964).

An investigation was made on the embrittling effect of hydrogen in Zr alloys containing Ni, Cu, Fe, or Nb. Impact results for the various materials showed that all the alloys tested were susceptible to hydrogen embrittlement, although the degree of embrittlement is masked in some instances by the inherent brittleness of the unhydrided alloy. The results also showed that, regardless of the toughness of the unhydrided material, the energy absorbed in impact at room temperature is invariably reduced to approximately 5 ft/lb when the hydrogen content reaches about 200 ppm. It was also noted that hydrided materials show a transition to higher impact energies at higher testing temperatures. (P.C.H.)

34170 THE INFLUENCE OF ORGANIC ADDITIONS ON THE SOLARIZATION AND GRAIN GROWTH OF SINTERED UO_2. I. Amato and R. L. Colombo (FIAT, Turin). J. Nucl. Mater., 11: 348-51(Apr. 1964).

Uranium dioxide pellets containing from 0 to 2 wt % organic binder (made of 1 part of PVA and 1 part of polyethylene glycol), plus 0.2 wt % stearine, which was added in each case, but supposed to have no practical influence on the results, were pressed to 5–6.5 g/cm^3 and sintered in hydrogen; the rise to the soaking temperature being at the rate of about 300°C/hr. The results showed that the duration of the stay at temperature beyond the time necessary to attain the maximum density is detrimental to the final density only in the presence of organic binder. Solarization was the more severe, the higher the soaking temperature and the green density. However, it was doubtful whether 2 wt % organic binder caused more severe solarization than 1 wt %. At high green densities the presence of the binder very soon inhibited any grain growth, which, in absence of binder, was larger, the higher the green density. (P.C.H.)

34171 SINGLE CRYSTAL STUDY OF AN ALPHA-PLUTONIUM–NEPTUNIUM ALLOY. A. F. Berndt (Argonne National Lab., Ill.). J. Nucl. Mater., 11: 352(Apr. 1964).

A melt containing 43.4 at. % Pu in Np was prepared and cooled at 0.5°C/hr from the liquid to 260°C, held at this temperature for 5 weeks and furnace cooled. Metallographic examination of the specimen showed the existence of large grains. Since the specimen was brittle, a single grain particle (about 0.02 × 0.02 × 0.01 mm in size) was fractured from it, isolated, and mounted for x-ray examination. The crystal was oriented by means of oscillation photographs to rotate about an axis of length 19.37 A. Rotation and Weissenberg photographs were used to determine the unit cell to be monoclinic. (P.C.H.)

34172 THERMAL CONDUCTIVITY OF UO_2, UC, AND UC_2. Tadashi Kubota, Yoshinobu Seki, and Shuichiro Takahashi (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan). J. Nucl. Sci. Technol. (Tokyo), 1: 93-100 (June 1964).

Thermal conductivities of UO_2, UC, and UC_2 were measured. There was no clear evidence of the increase of thermal conductivity of UO_2 in the temperature range between 1000 and 1600°C, although the effect of radiation transfer mechanism was thought to play a role from the tendency that the decrease of thermal conductivity did cease around 1200°C. Thermal conductivities of sintered UC and UC_2 pellet—both 95% T.D.—were measured by axial heat flow method. Thermal conductivity of UC was around 0.05 ~ 0.04 cal/sec · cm· °C at the temperature range between 100 and 400°C, while measured values on UC_2 were around 0.016 ~ 0.014 in the temperature range between 200 and 400°C. (auth)

34173 ESTIMATION OF A CHANGE OF THE CURIE TEMPERATURE WITH PRESSURE FOR GADOLINIUM. Tetsuo Nakajima and Hideo Takaki (Kyoto Univ.). J. Phys. Soc. Japan, 19: 951-4(June 1964).

A change of the Curie temperature with pressure for gadolinium was estimated from the data of the temperature dependences of the magnetization and magnetostriction on the basis of thermodynamical theory of a phase transition of the second kind. This result is in good agreement with the experimental result. (auth)

34174 PENETRATION OF URANIUM FROM A URANIUM–NIOBIUM–ZIRCONIUM ALLOY INTO MOLYBDENUM BY DIFFUSION. G. B. Fedorov and F. I. Khomov. Met. i Metalloved. Chistykh Metal., Sb. Nauchn. Rabot, No. 4, 64-8(1963).

The interaction between Mo and a U alloy containing 25% Nb and 5% Zr was investigated. Two samples of Mo in the form of tablets 10 mm in diameter and 6-8 mm high and a sample of the U alloy of the same dimensions inserted between them were placed in a tubular Mo container and annealed in an evacuated quartz ampoule filled with Ar at 900–1200°C. A grayish-yellow film a few hundredths of a millimeter thick formed on the contact surface of the Mo samples. The presence of the intermediate phase $ZrMo_2$ was established by x-ray diffraction. Matako's method was used to calculate the activation energy of diffusion of U out of the alloy and into Mo, which was found to be 46 kcal/g-atom, and the preexponential factor, which was found to be equal to 5×10^{-4} cm^2/sec. (Referativnyy Zhurnal, Metallurgiya, No. 4, 1964)

34175 THE ELASTIC PROPERTIES AT HIGH TEMPERATURE OF STAINLESS STEEL IN THE DESIGN OF COATING PIPES FOR FUEL IN THE WATER REACTORS. A. Bray (Istituto Dinamometrico Italiano CNR, Turin), R. Colombo, and A. Petruccioli Balzari. Met. Ital., 56: 210-12(June 1964). (In Italian)

Relations between σ_e, E, ν, and temperature, and σ_p, ϵ_p, and temperature were determined by means of a computer by using experimental values. As a further step the relations where worked out in order to calculate the maximum pressure that a pipe, such as stainless steel, can withstand before collapsing for instability (elastic conditions) or yielding (plastic conditions). (P.C.H.)

34176 ALUMINUM AND MAGNESIUM IN REACTORS. PART 2. L. M. Wyatt. Metal Ind. (London), 104: 288-91 (Feb. 27, 1964).

The chemical composition and physical and mechanical properties are presented for Magnox type Mg alloys used as reactor canning materials. The alloys have a lower neutron capture cross section as compared to Al, do not react with uranium, and the Pu diffusion is very low at the reactor working temperature. (Rev. Metal Lit., 21: (June 1964))

34177 ON NIOBIUM–GAS SYSTEMS. E. Gebhardt, E. Fromm, and R. Rothenbacher (Max-Planck-Institut für Metallforschung, Stuttgart). Metall, 18: 691-6(July 1964). (In German)

The studies made on niobium–gas systems at the Max

Planck Institute are briefly reviewed. Equlibrium in the Nb–N system, solubility of oxygen in Nb, property changes in Nb caused by dissolved O_2 and N_2, precipitation processes from supersaturated Nb–gas mixtures, and degassing of Nb are discussed. (J.S.R.)

34178 REFRACTORY METALS—MATERIALS USED IN MODERN TECHNICS. R. Palme (Metallwerk Plansee Aktiengesellschaft, Reutte/Tirol, Austria). Metall, 18: 697-700(July 1964). (In German)

The principal properties of the refractory metals Mo, W, Nb, and Ta are summarized. Recent developments in the processing of these metals are indicated. Their utilization in oven construction, space flight, and reactor technology is described. The principal alloys of these metals and their uses are considered. (J.S.R.)

34179 SIGNIFICANCE OF REFRACTORY METALS FOR THE PRODUCTION OF HIGH-FIELD SUPERCONDUCTORS. D. Koch (W. C. Heraeus GmbH, Hanau, Ger.). Metall, 18: 714-18(July 1964). (In German)

The principles of superconductivity are summarized. The preparation and applications of hard superconductors from Nb, Zr, Mo, Ta, and V and their alloys are described. The difficulties in the fabrication of their intermetallic compound superconductors are indicated. Development for future possible applications of special hard superconductors is considered. (J.S.R.)

34180 REACTOR METALS AND REFRACTORY METALS—TITANIUM, ZIRCONIUM, NIOBIUM, TANTALUM, MOLYBDENUM, AND TUNGSTEN. H. W. Wagener. Metall, 18: 718-26(July 1964). (In German)

The physical and mechanical properties of the refractory metals Ti, Zr, Nb, Ta, Mo, and W and their alloys are briefly reviewed. (J.S.R.)

34181 PARTICULAR PROPERTIES OF METALS IN REACTOR ENGINEERING. E. Lijbrink. Metallen, 19: 107-10(1964).

A description of the problems in the choice of materials for the building of pressure vessels for nuclear reactors is presented. Studies concerning brittle fracture and creep properties are important. Brittle fracture is affected by thickness of the plates, stress concentrations, notching, macrostructure, dissolved carbon and nitrogen, annealing, and lattice defects as a result of radiation damage. Silicon and aluminum have a large influence on the creep properties. (NPO)

34182 THE FINE-GRAINED STRUCTURE IN A MAGNESIUM–ZIRCONIUM ALLOY CO-EXTRUDED WITH PURE MAGNESIUM. Shotaro Morozumi, Michio Kikuchi, and Shigeyasu Koda (Tohoku Univ., Sendai). Nippon Kinzoku Gakkaishi, 28: 244-8(1964). (In Japanese)

An anomalous fine-grained structure of Mg–Zr alloy phase was observed in the annealed co-extrusion of Mg–0.5% Zr and Mg–1% Al powders. An investigation was carried out to clarify this phenomenon. A cylindrical bimetal billet of pure Mg and Mg–0.5% Zr alloy was extruded at 400°C and the extruded bimetal was annealed at 350 ~ 550°C for 1, 3, and 9 hr. The grain size of Mg–Zr alloy phase near the interface to the pure Mg phase was measured and plotted against the distance from the interface. The fine-grained zone of about 0.3 mm in the Mg–Zr alloy phase adjacent to the pure Mg phase was observed in the as-extruded condition. Annealing the extruded bimetal at 550°C resulted in remarkable grain growth in the opposite side of this zone to the interface. The fine-grained zone, however, remained in the extent of ~0.1 mm. This fine-grained structure of Mg–Zr alloy phase seems attributable not to an ordinary deformation mechanism in the extrusion process of a single billet but to another mechanism caused by the co-extrusion with a softer material. (auth)

34183 RESISTIVITY OF Mo–Nb AND Mo–Re ALLOYS CONTAINING 1% Fe. M. P. Sarachik, E. Corenzwit, and L. D. Longinotti (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 135: A1041-5(Aug. 17, 1964).

The resistivity of a series of Mo–Nb and Mo–Re alloys, with and without 1% Fe, was measured at room temperature, and between 1.5 and 77°K. Large effects are observed near the alloy composition where the iron acquires a localized magnetic moment. These effects appear both as an excess temperature-independent scattering and in the form of large anomalies at low temperatures. Interpreted in the light of current theories of localized moments, the resistivity results confirm the existence of virtual bound states near the Fermi level. In addition, the anomalous behavior of the resistivity at low temperatures was directly related to the existence of a localized magnetic moment. (auth)

34184 FUSION CURVE OF EUROPIUM, FUSION, AND fcc-bcc TRANSFORMATION IN YTTERBIUM AT HIGH PRESSURES. A. Jayaraman (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 135: A1056-9(Aug. 17, 1964).

The melting behavior of Eu to 70 kbar and melting and f-c-c to b-c-c transformation in Yb to 40 kbar were studied. Europium has a maximum in the fusion curve at about 35 kbar and 995°C and retains the b-c-c structure in the pressure and temperature range investigated. The fusion curve of Yb has an initial slope of 19°/kbar and rapidly flattens in the 35-kbar region. There appears to be only one f-c-c to b-c-c phase boundary and not two as proposed in an earlier study. This boundary intersects the temperature axis close to the known f-c-c to b-c-c transformation temperature at atmospheric pressure, and an initial slope of –16°/kbar is suggested. This transformation in Yb behaves exactly like the analogous transformation in Sr, exhibiting pressure and temperature hysteresis and also reversing the sign of the resistance discontinuity above 24 kbar. The striking parallelism in high-pressure behavior between Eu and Ba and Yb and Sr is discussed. The greater density of the b-c-c phase compared to f-c-c or h-c-p noted in several instances is rationalized. The melting behavior of Eu is discussed from the standpoint of coordination in the liquid state. (auth)

34185 FERMI SURFACE OF ZIRCONIUM. S. L. Altmann and C. J. Bradley (Oxford Univ.). Phys. Rev., 135: A1253-6(Aug. 31, 1964).

The Fermi surface of zirconium, as computed by means of the cellular approximation, is given. This departs fundamentally from the free-electron Fermi surface and allows an interpretation of the recent de Haas-van Alphen results obtained by Thorsen and Joseph. The right value (up to a factor of about 2) and the right angular dependence is given for four out of the five periods found by these authors. The free-electron Fermi surface, after some modification, accounted for one period only. (auth)

34186 DIRECT OBSERVATION OF DISLOCATIONS IN Si SINGLE CRYSTALS USING A WHITE X-RAY RADIATION TECHNIQUE. L. Fiermans (Rijksuniversiteit, Ghent). Phys. Status Solidi, 6: 169-72(1964).

A new method is described for the direct observation of dislocations in silicon single crystals. It is based on the use of white x radiation, and gives, on a single photograph, information about the Burgers vectors of the dislocations. (auth)

34187 SPIN WAVE ENERGIES AND EXCHANGE PARAMETERS IN IRON–NICKEL ALLOYS. M. Hatherly, K. Hirakawa, R. D. Lowde, J. F. Mallett, M. W. Stringfellow, and B. H. Torrie (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Phys. Soc. (London), 84: 55-62(July 1964).

The energies of long-wavelength spin waves in Fe–Ni alloys were measured as a function of composition, using a neutron small-angle scattering technique. The composition dependence can be explained in terms of a simple model invoking long-range interaction functions J(r) between the three different types of atom pair, Fe–Fe, Fe–Ni, and Ni–Ni. There is evidence that on the body-centered cubic lattice interaction J(r) changes sign from positive to negative as a function of distance. Between Fe–Fe pairs on a face-centered cubic lattice, the exchange integral as normally defined is found to be -9 ± 2.6 Mev, which is consistent with other indications that fcc iron is antiferromagnetic. (auth)

34188 THE TEMPERATURE DEPENDENCE OF MAGNETIC ORDERING IN THE HEAVY RARE EARTH METALS. R. J. Elliott and F. A. Wedgwood (Oxford Univ.). Proc. Phys. Soc. (London), 84: 63-75(July 1964).

The wave vector q of the magnetic order observed in the heavy rare earth metals is calculated using a model with an exchange interaction between the localized moments and the conduction electrons which are assumed to be free. For a finite amount of order, energy gaps appear in the conduction bands at new Brillouin "superzone" boundaries associated with q. The Fermi surface is distorted by these boundaries. The total energy of the system is calculated for finite order and minimized with respect to q. For small order this leads to the usual Ruderman–Kittel result, but as the order increases the value of q at the minimum decreases. The agreement with experiment is good for the simple model of Tm, Er, and Ho, but less satisfactory in Dy and Tb, where spin–disorder scattering is important. A modification of this model also accounts for the behavior of the electrical resistivity. It indicates that the real Fermi surface lies just inside the plane hexagonal faces of the Brillouin zone, and that a large area of it is destroyed by the magnetic ordering. (auth)

34189 COLUMBIUM: THE METAL OF THE FUTURE. Roger Durand and Jean Fabry. Tech. Mod., No. 12, 591-9 (Dec. 1963). (In French)

The preparation and transformation of Nb are reviewed, including the preparation of high purity Nb and Nb powders and the production of ingot and finished products from the powders. The physical and mechanical properties of the metal, corrosion resistance and applications in the metallurgy of steel, chemical industry, aeronautics, electricity, and electronics are discussed. (Rev. Metal Lit., 21: (June 1964))

34190 STUDY OF THE THERMAL EXPANSION OF TUNGSTEN, MOLYBDENUM, TANTALUM, NIOBIUM, AND ZIRCONIUM AT HIGH TEMPERATURES. V. M. Amonenko, P. N. V'yugov, and V. S. Gumenyuk (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Teplofiz. Vysokikh Temp., 2: 29-31(Jan.-Feb. 1964).

A study was made of the thermal expansion of tungsten, molybdenum, tantalum, and niobium in the temperature range up to 2000°C, and of zirconium up to 1450°, using a vacuum resistance dilatometer. An empirical temperature dependence of the elongation per unit length and of the true coefficient of linear expansion is given for all the materials investigated. Data obtained for the elongation of tantalum, molybdenum, and tungsten are in accord with previous results of others. Data on the expansion of niobium somewhat exceed those of others, probably because of the presence of impurities in the niobium. Graphs are given for the elongation of niobium, tantalum, molybdenum, and tungsten versus temperature, and for the coefficients of linear expansion of niobium, tantalum, molybdenum, and tungsten versus temperature. (OTS)

34191 SELF-DIFFUSION STUDIES OF DELTA PLUTONIUM. R. E. Tate (Los Alamos Scientific Lab., N. Mex.) and E. M. Cramer. APPENDIX: LEAST-SQUARES TECHNIQUE FOR ESTIMATING DIFFUSION PARAMETERS. A. S. Goldman. Trans. AIME, 230: 639-44(June 1964).

The diffusion coefficient for self-diffusion of plutonium in the temperature range 350 to 440°C was measured by using ^{238}Pu as the tracer. Autoradiographic techniques were used to investigate the possibility of grain boundary diffusion, but only evidence for volume diffusion was found. The least-squares fit of the data gives the following equation for the diffusion coefficient: $D = 4.5 \times 10^{-3} \exp[-23{,}800/RT]$ cm^2/sec. The computer least-squares technique for fitting the nonlinear equations is outlined. (auth)

34192 THE ROLE OF COPRECIPITATION IN ALLOY PARTITION DURING THE CRYSTALLIZATION OF TERNARY SYSTEMS. J. L. Moriarty, Irving Johnson, and H. M. Feder (Argonne National Lab., Ill.). Trans. AIME, 230: 777-80(June 1964).

The crystallization of ternary alloys was studied as a coprecipitation phenomenon by measuring the substitutional carrying of trace metals with $CeCd_{11}$ precipitating from liquid cadmium. The Doerner-Hoskins logarithmic distribution law was found to apply in all cases; the coprecipitation coefficients obtained were: 1.48 (La), 1.06 (Th), 0.63 (Pr), 0.24 (Gd), 0.17 (Sm), 0.13 (U), 0.10 (Er), 0.09 (Sr). Li, Na, K, Ba, Y, Sc, and Zr were not measurably carried. It was observed that coprecipitation was most extensive for those tracers that form with cadmium an intermetallic compound isostructural with $CeCd_{11}$ or closely related thereto. For these tracers an inverse relation between solubility in cadmium and coprecipitation coefficient was noted. (auth)

34193 A STUDY OF BASAL SLIP KINK BANDS IN POLYCRYSTALLINE ZIRCONIUM. J. L. Martin and R. E. Reed-Hill (Univ. of Florida, Gainesville). Trans. AIME, 230: 780-5(June 1964).

Kinking is an important deformation phenomenon in polycrystalline α-zirconium. The crystallographic features of the most important form of kinking were determined with the aid of twins formed at 77°K in grains previously kinked at high temperatures. It was found that the kink-band boundaries correspond to walls of edge dislocations with $\langle 11\bar{2}0 \rangle$ Burgers vectors and dislocation lines parallel to $\langle 0\bar{1}10 \rangle$. The observations implied that basal slip is an important secondary-slip mode in polycrystalline zirconium. Previous single-crystal studies did not reveal this mode. Other evidence for $\{0002\}\langle 11\bar{2}0 \rangle$ slip is also presented. (auth)

34194 EFFECT OF RECOVERY ON THE TENSILE FLOW BEHAVIOR OF MOLYBDENUM. J. L. Lytton (Lockheed Missiles and Space Co., Palo Alto, Calif.) and T. E. Tietz. Trans. AIME, 230: 802-8(June 1964).

The recovery of flow stress of recrystallized arc-cast molybdenum after 10% prestrain at 150°C was studied for recovery temperatures of 725, 801, and 901°C. The yield phenomenon observed after recovery was such that the yield drop diminished and disappeared as recovery proceeded. A fractional flow-stress recovery parameter f_r was developed

and it is shown that, independent of recovery temperature, equal f_r values of about 0.16 produced superposition of stress-strain curves except for the initial yield phenomenon. The activation energy for low degrees of recovery was found to be 32,600 cal per mole, in close agreement with a reported value for diffusion of carbon in molybdenum. For values of f_r greater than about 0.15, where recovery was thought to predominate over strain aging, the activation energy varied from 43,600 to 82,500 cal per mole and increased with increasing recovery and recovery temperature. A 10% prestrain shifted the ductile-brittle transition temperature, as indicated by tensile elongation, from 10°C to about −22°C. A 100-hr recovery anneal at 801°C was shown to shift the transition temperature to about −5°C, the major shift occurring during the first hour of recovery. (auth)

34195 AN INVESTIGATION OF THE LEAD MOLYBDATE-BISMUTH MOLYBDATE PHASE DIAGRAM. D. F. Howard (Air Proving Ground Center, Eglin AFB, Fla.), G. P. Bowman, R. K. Saxer, and J. R. Myers. Trans. AIME, 230: 850-3(June 1964).

The phase diagram of the lead molybdate-bismuth molybdate salt system was redetermined. A portion of this diagram was originally determined by Zambonini in 1920, and more recently by Beale. Thermal analysis and x-ray methods were used to define this system. The diagram was found to be a simple eutectic type with an eutectic at 11 mole % lead molybdate and 634°C. A maximum solid solubility of 6 mole % was found at the lead molybdate end of the diagram. Solid solubility at the bismuth molybdate end of the diagram appeared to be quite limited and possibly nonexistent. These results generally agreed with those of Beale, but differed significantly from those of Zambonini. (auth)

34196 EFFECT OF OXYGEN ON THE IMPACT TRANSITION PROPERTIES OF WROUGHT TANTALUM AND COLUMBIUM. A. G. Imgram, E. S. Bartlett, and H. R. Ogden (Battelle Memorial Inst., Columbus, Ohio). Trans. AIME, 230: 928-30(June 1964).

The effects of interstitial oxygen on the impact properties of wrought, fibered tantalum and niobium are described and the transition behavior is compared to previously determined tensile transition characteristics. Pure tantalum showed a slight increase in energy absorbed in an impact test with decreasing temperature. The addition of 490 ppm oxygen appeared to cancel the effect of temperature on impact energy. The addition of 760 ppm oxygen resulted in slight loss of impact energy with decreasing temperature. The impact resistance of pure niobium decreased slightly as the temperature was lowered from −80 to −196°C. Niobium containing 480 ppm oxygen had slightly better impact resistance than pure niobium at room temperature and above; however, its impact resistance decreased sharply below −40°C and was significantly inferior to pure niobium at −196°C. The impact behavior of niobium containing 1320 ppm oxygen was inferior to that of the other samples at all temperatures. (M.C.G.)

34197 DISPERSION-STRENGTHENED REFRACTORY ALLOYS. R. C. Westgren and V. R. Thompson (Crucible Steel Co. of America, Pittsburgh). Trans. AIME, 230: 931-4(June 1964).

A study was undertaken to determine to what extent the introduction of carbide dispersions would strengthen a solid-solution tungsten-base alloy. A base composition of tungsten and 10 to 12% niobium was selected. Additions of V, Zr, and C were tested. These small additions significantly increased the tensile strength of the Nb−W alloy. (M.C.G.)

34198 THE BRITTLENESS OF ALPHA PLUTONIUM. L. Ianniello (U. S. Atomic Energy Commission, Washington, D. C.). Trans. AIME, 230: 940-2(June 1964).

Electrorefined plutonium was rolled under various conditions and examined to determine the strain-hardening characteristics and also to determine under what conditions rolling could be performed. Results indicated that the main factors influencing the deformability of α-plutonium are: prior thermal history, strain rate, and stress conditions. Heavily deformed α-plutonium was found to have moderate ductility, but still had to be considered brittle relative to most metals. It was concluded that it would possibly be even more brittle if it were not for self-irradiation effects. (M.C.G.)

34199 A STUDY OF TRIVALENT-PENTAVALENT OXIDE SYSTEMS. A. J. Dyer and E. A. D. White (General Electric Co. Ltd., Wembley, Eng.). Trans. Brit. Ceram. Soc., 63: 301-12(June 1964).

Compounds occurring in the systems $A_2O_3-B_2O_5$, where A_2O_3 is a Group III or rare earth oxide and B_2O_5 is niobia or tantala, were prepared as sintered discs. The phases formed in the systems are described and summarized. Permittivity/temperature and resistance/temperature curves up to 500°C were plotted for the preparations, and anomalies in these curves for some compositions are discussed. Cathodoluminescence is shown by all compounds of composition ABO_4; these effects appear to be independent of both the structure-type and the presence of activators. (auth)

34200 SUPERCONDUCTIVE WIRE. Peter J. Ottowitz. Wire and Wire Prod., 39: 407; 433; 435(Mar. 1964).

Description is given of materials used for superconductive wires. Data are given on superconductivity temperatures, critical magnetic field, and critical transition temperatures of elemental materials as well as some intermetallic compounds and alloys such as Nb−Sn, V−Ga, and Nb−Zr. Classification of superconductive materials according to their brittleness and ductility and the properties of both categories are discussed. (Rev. Metal Lit., 24: (June 1964))

34201 WHY REFRACTORY METALS? N. E. Promisel (Dept. of the Navy, Washington, D. C.). p.3-13 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Uses of refractory materials at high temperatures and reasons for concentrating on tungsten, tantalum, molybdenum, and niobium are discussed. Applications in propulsive systems, electric power generation for space vehicles, structural applications, and nuclear systems are described. (M.C.G.)

34202 THE ELECTRONIC STRUCTURE AND ALLOYING CHARACTERISTICS OF THE EARLY TRANSITION METALS. A. D. McQuillan (Univ. of Birmingham, Eng.). p.51-61 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

The electronic structure of the early transition metals is considered a complex problem unlikely to yield to a completely theoretical attack without the aid of a general picture built up by examination of the physical properties of alloys of the metals. The most promising physical properties were found to be the temperature coefficient of electronic specific heat, magnetic susceptibility, and possibly, the critical temperature for superconductivity. Results obtained so far are reviewed. Technologically the most im-

portant alloying property of the metals is the ability of certain members of the group to take into solution large quantities of non-metallic elements. The decrease in this ability to dissolve interstitial atoms with increasing electron/atom ratio of alloys is discussed, and correlated with changes in physical properties. (auth)

34203 STRUCTURAL CONSIDERATIONS IN DEVELOPING REFRACTORY METAL ALLOYS. Leslie L. Seigle (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). p.63-93 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Available data concerning the effect of solutes on the strength and hardness of niobium, tantalum, molybdenum, and tungsten were collected and reviewed. The interstitial solutes increased room-temperature hardness and strength of niobium and tantalum, and presumably tungsten and molybdenum, at a much more rapid rate than substitutional solutes, but had no effect at elevated temperatures where dislocation locking by interstitials was absent. A correlation existed between the strengthening effect of substitutional solutes and group number in the periodic table, which suggested that the rate of strengthening of niobium, tantalum, molybdenum, and tungsten by substitutional solutes is related primarily to the increase in electron-atom ratio. Size effect played a secondary role in solid solution strengthening. A feature of the alloying behavior of the refractory metals is the possibility of interactions between interstitial and substitutional solutes, which are known, or presumed, to underlie several types of anomalies in the variation of strength and hardness with solute content. (auth)

34204 THE INTERACTION OF INTERSTITIAL SOLUTE AND SUBSTRUCTURE IN REFRACTORY METALS. D. Hull and W. S. Owen (Univ. of Liverpool). p.95-109 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Recovery and recrystallization of severely cold-worked refractory metals and structures that develop on deforming of annealed materials are discussed. Effects of interstitial solutes on substructure of crystals are considered. The association of interstitial atoms and dislocations was found to result in the appearance of a discontinuous yield, with the initial deformation produced by Lüders bands sweeping through the specimen. Strain-hardening behind the Lüders front was observed. The role of substructure and interstitial atoms on brittle fracture was also studied. (M.C.G.)

34205 THE PHYSICAL PROPERTIES OF REFRACTORY METALS WITH REFERENCE TO OTHER ENGINEERING MATERIALS. E. Gebhardt and R. Rothenbacher. p.157-73 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

The properties of Nb, Ta, Mo, and W that are of particular importance in science and engineering are discussed. The physical properties of the pure metals, the effects of alloyings on these metals, and changes in properties that result from reactions between metals and gases are described. (M.C.G.)

34206 THE EFFECTS OF TRACE ELEMENTS ON THE MECHANICAL PROPERTIES OF REFRACTORY METALS. A. J. Nicol-Smith and L. Northcott. p.175-90 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

After an assessment of the mechanical properties required for successful fabrication and use of the refractory metals for various purposes, the areas of difficulty at the present time are discussed. It was concluded that fabrication and component manufacture are subject to handicaps, the removal of which is of major importance. The present state of fabrication and use of the refractory metals is considered from the point of view of the way in which the mechanical properties are affected by trace elements. Trace elements are grouped into interstitial elements; substitutional solid solution impurities; substitutional solid solution additions; compounds, inclusions, precipitates and dispersoid systems; and major alloy additions that are discussed from the point of view of their interaction with impurities and their influence in controlling the effects of impurities. The role of the body-centered cubic structure is considered and general effects of interstitial elements reacting with dislocations are discussed with consideration of room-temperature mechanical properties, yield point phenomena, transition temperatures, strain aging, and the temperature dependence of tensile properties. Interstitial elements are reviewed in terms of their origin, pick-up, and removal, for example by deoxidation reactions. The various methods of nullifying the effects of such impurities are considered. Their influence on such matters as welding is discussed. Major problems connected with the influence of trace elements on the mechanical properties, an assessment of the present lines of attack, and some suggestions for discussion are listed. (auth)

34207 DETERMINATION AND APPLICATION OF THERMOPHYSICAL PROPERTIES OF REFRACTORY METALS. G. D. Rieck (Technical Univ., Eindhoven, Netherlands). p.205-17 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

The thermophysical properties of tungsten, tantalum, molybdenum, and niobium, methods of determining these properties, and their application are discussed. The properties described are: diffusion under the influence of a temperature gradient, emissivity, heat capacity, thermal conduction, and liability to structural change when heated. (auth)

34208 EFFECTS OF HIGH-ENERGY RATE-FORMING ON PROPERTIES OF REFRACTORY METALS. C. A. Verbraak (TNO, Rijswijk, Netherlands). p.219-31 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Results from work on explosively loaded single crystals of various fcc and bcc metals, especially molybdenum, are given. The anisotropy of shock wave deformation is discussed. It was observed that the $-\frac{1}{3}(211)$ type of twinning may occur during the explosive deformation of molybdenum. The resolved shear stress seemed to make a limited selection of possible twinning systems. The tendency of twinning in molybdenum even at peak pressures as low as 20 kbar was not a promising aspect for the application of explosive forming. (M.C.G.)

34209 DEVELOPMENT AND EVALUATION OF COATINGS FOR EARTH RE-ENTRY SYSTEMS. E. G. Czarnecki and M. T. Braun (Boeing Co., [Seattle]). p.357-68 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

Development and testing of refractory metal coatings for earth re-entry systems are discussed with particular

emphasis on the environment, coating applications, testing facilities, test results, and recommendations for future work. While re-entry coatings must function through the complete flight cycle of boost, orbit, and re-entry, the primary emphasis is placed upon the temperatures, pressures, gas states, strains, mass transfer, time, and other parameters experienced during the re-entry portion of the mission. After a discussion of the requirement for considering the coating and parent material as a single system, the principal requirements of the coated material in terms of oxidation protection at temperature, emittance, and chemical compatibility are presented. The methods of application of disilicide coatings to molybdenum and niobium are compared. Facilities capable of simulating portions of the environment, including plasma jets, vacuum chambers, wind tunnels, and others are discussed and the degree of simulation available from each facility are compared. Typical test data from advanced methods of application are presented, including emittance, oxidation life, and chemical compatibility. Future coating and material systems requirements for earth re-entry are considered and recommendations for future developments of coating-material systems and test facilities are presented. (auth)

34210 EVALUATION OF TEST METHODS FOR REFRACTORY METALS. D. Coutsouradis (Centre National de Recherches Métallurgiques, Liège). p.421-49 of "The Science and Technology of Tungsten, Tantalum, Molybdenum, Niobium, and Their Alloys." Oxford, Pergamon Press, 1964.

The tensile test for determination of tensile, creep, and stress-rupture strengths of refractory metals is described. The following factors having an influence on the tensile test results are discussed: specimen dimensions, gripping methods, surface finish, pretest inspection, loading apparatus and loading, strain measurement and strain rate, room-temperature control, heating and temperature control, and test environment. (M.C.G.)

34211 A STUDY OF THE NIOBIUM–ZIRCONIUM–CARBON AND NIOBIUM–ZIRCONIUM–OXYGEN SYSTEM. A. C. Barber and P. H. Morton. (Imperial Metal Industries (Kynoch) Ltd., Birmingham, Eng.). 18p. (CONF-524-14)

From American Institute of Mining, Metallurgical and Petroleum Engineers Annual Meeting, New York, Feb. 1964.

Phase studies were made on the C–Nb–Zr and O–Nb–Zr systems. Isothermal sections of the Nb-rich corners of the Nb–Zr–C and Nb–Zr–O ternary systems at 1300 and 1000°C, respectively, are presented. Phase extraction, x-ray diffraction, and conventional metallographic techniques were used and the type, size, form, and dispersion of compounds was studied. In the Nb–Zr–C system, two carbides of importance exist: hexagonal Nb_2C and cubic ZrC. At 1300°C ZrC exists in a dispersed but somewhat coarse form, whereas Nb_2C is unsuitable for strengthening effects because it exists in coarse angular form and precipitates at grain boundaries. In the Nb–Zr–O system a find dispersion was observed. The isothermal section presented illustrates the marked reduction in oxygen solubility in Nb, which is brought about by very small additions of Zr. The solubility of 1000°C for instance is 3800 ppm in unalloyed Nb, while for Nb-1 wt % Zr it is less than 100 ppm. (P.C.H.)

34212 GRAIN GROWTH AND SINTERING OF $Y_{0.33}Zr_{0.67}O_{1.83}$. D. D. Button (Westinghouse Research Labs., Pittsburgh). 20p. (CONF-553-2)

From American Ceramic Society 66th Annual Meeting Including Symposium on Nuclear and Space Applications, Chicago, Apr. 1964.

The sintering and grain growth of a fluorite-type cubic solid solution of $Y_{0.33}Zr_{0.67}O_{1.83}$ was studied isothermally in the temperature range 1600-2000°C. The time exponent for grain growth at each temperature was determined and compared with the exponent predicted by grain growth laws. Activation energies for the grain growth process were calculated. The influence of atmosphere on sintering and grain growth was determined. (auth)

Radiation Effects

Refer also to abstracts 33913 and 33914.

34213 (AI-64-11) THE EFFECTS OF RADIATION ON NICKEL–CADMIUM BATTERY ELECTRODES. [PART] I. Final Report June 1–December 31, 1963. G. R. Argue, H. L. Recht, W. A. McCollum, and D. E. McKenzie (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 6, 1964. Contract J.P.L.-950514. 48p. (NASA-CR-55760; N64-16014)

The effects of various types of radiation on the electrochemical and physical characteristics of nickel and cadmium electrodes were studied. The investigation usually employed electrodes in the flooded condition. Gamma irradiation caused material loss from the electrodes and a buildup in gas pressure in sealed cells. Decreases were also observed in cell voltage and capacity. Material loss was also observed in electron irradiation. (T.F.H.)

34214 (EURAEC-1126) FISSION GAS RELEASE FROM URANIUM DIOXIDE. Final Report. I. Amato, G. Frigerio, and T. Gerevini (FIAT. Sezione Energia Nucleare, Turin). June 30, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 021-60-9-RDI. 59p. (FN-E-45)

Post-irradiation annealing experiments were conducted to study the relations between the properties of sintered UO_2 and its fission gas retention capacity. Sintered UO_2 pellets of densities 90 to 95% theoretical were irradiated below 100°C and then annealed for 6 hr at 1330 to 1800°C. For most samples, a burst release occurred when the temperature was first increased, followed by a linear release after 0.5 to 3 hr. Bursts also occurred during the cooling-down of the samples, providing the cooling rate was sufficiently high, on the order of 10°C/sec, and possible causes of this effect are discussed. The release rate parameter D′ was found to decrease with dose from 10 to 100 Mwd/t; at higher doses, the decrease had a tendency to saturate, with a recovery of previous D′ decreases in some cases. No correlation of the bursts or dose dependency of D′ with pellet properties or annealing temperature was found. The activation energy for Xe diffusion in UO_2 was determined to be 70 to 90 kcal/mole at 1300 to 1600°C. (D.L.C.)

34215 (GEAP-4624) UO_2 PELLET THERMAL CONDUCTIVITY FROM IRRADIATIONS WITH CENTRAL MELTING. M. F. Lyons, D. H. Coplin, T. J. Pashos, and B. Weidenbaum (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 38p. (EURAEC-1142)

Continued irradiation experience under the AEC–Euratom, UO_2 High Performance Program has provided five separate and distinct sets of data on UO_2 thermal conductivity. Four of these results are expressed in terms of

the value of the thermal conductivity integral to melting. The first two of these measurements were applicable—strictly—to polycrystalline UO_2. Recently, three additional sets of measurements have been obtained—all pertinent to UO_2 after the formation of large columnar grains. The extent of melting in the experiments on which the results are based ranges from slight, to greater than 70 percent of the fuel cross section. The conclusions from all of these thermal conductivity measurements considered together are: (1) The true value of the UO_2 conductivity integral from 0°C to melting (2805 ± 15°C) lies in the range from 90 to 96 w/cm. The most probable value is closer to 90 w/cm. To ensure no central melting and the associated clad swelling, the maximum thermal performance level for solid pellet, UO_2 fuel rods should not exceed 90 w/cm. (2) Any improvement in thermal conductivity due to the formation of large, columnar UO_2 grains is small and not detectable within the experimental accuracy of the measurements, i.e., 3 to 4 w/cm. (auth)

34216 (NASA-TN-D-2364) AN EXPERIMENTAL INVESTIGATION OF RADIATION EFFECTS IN SEMICONDUCTORS. W. Dale Compton (Illinois. Univ., Urbana). July 1964. 10p.

The present experiments are concerned with the radiation-induced changes in the minority carrier lifetime of silicon, of the influence of radiation upon the recombination luminescence of germanium and silicon, and the influence of radiation upon the impurity conduction of germanium. A brief description is given of the techniques involved and the present status of these studies. (auth)

34217 (NP-14183) THE EFFECTS OF NUCLEAR RADIATION ON A WESTON CADMIUM CELL (thesis). Walter Bristol Windus (Washington State Univ., Pullman). 1962. 42p.

Unsaturated acid Weston cadmium cells were irradiated in the nuclear reactor at Washington State University continuously for a period of six hours at a neutron flux of 5×10^{11} n/cm^2 sec and a gamma flux of 3×10^7 rad. The temperature of the cells rose 55°F above the ambient temperature of 78°F. This was caused by heat generated within the cell due to irradiation. The flux gradient caused unequal heating in the cell resulting in significant temperature differences between the two legs. After elimination of the temperature effects the voltage of the cell decreased about 0.21 per cent due to radiation. The voltage recovered to its original value in about three weeks. Two weeks after radiation the internal resistance had increased to a value four times the original value. One week later it was steady at twice the original value. The Pyrex glass container had turned light brown and a fine black precipitate was observed in the solution of cadmium sulfate. (auth)

34218 (ORNL-TM-881) IN-REACTOR STRESS-RUPTURE PROPERTIES OF A 20 Cr–25 Ni, NIOBIUM-STABILIZED STAINLESS STEEL. J. T. Venard and J. R. Weir (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 27p.

There is widespread interest in the effect of neutron bombardment on the mechanical properties of the austenitic stainless steels because of their frequent application in reactor structures and fuel cladding. For this reason, a niobium-stabilized austenitic stainless steel (20 Cr–25 Ni–bal Fe) developed in the United Kingdom for gas-cooled reactor service has been tested in-reactor for its stress-rupture characteristics. The tests were performed by internally pressurizing tubes at temperatures of 550, 650, 750, and 850°C in a neutron flux of about 5.0×10^{12} nv fast (>2.9 Mev) and 6.0×10^{13} nv (thermal). Duplicate tests were performed ex-reactor. Brief details of test procedures and a discussion of the experimental results are presented. Only a small effect of irradiation on material strength was seen, but a strong effect of irradiation and temperature was observed on the fracture ductility. (auth)

34219 (RCN-26) THE NORWEGIAN-DUTCH STEEL IRRADIATION PROGRAMME. H. Skreppen, T. Boehler, A. Hanevik (Norway. Institutt for Atomenergi, Kjeller); and E. Lijbrink (Reactor Centrum Nederland, Petten). 1964. 17p.

The experimental work presented is part of the Norwegian-Dutch irradiation program carried out with the High Flux Reactor (HFR) at Petten, The Netherlands. The steel irradiation program comprises the investigation of the radiation damage in different pressure vessel steels. Each steel type, is irradiated to different integrated fast neutron fluxes (>1 Mev) between 5.10^{17} and 10^{20} n/cm^2 and at different temperatures from about 60°C to a maximum of 325°C. Four different steels have so far been irradiated at approximately 60°C and the damage in tensile and impact strength properties have been investigated. Experimental results showing the increase in transition temperature and tensile strengths properties with increasing integrated fast neutron fluxes are presented. (auth)

34220 (TID-20787) INFRARED SPECTRA OF PLASTICS AND ELASTOMERS AFTER NUCLEAR IRRADIATION. Research Report for 1963. W. C. Sears (Georgia. Univ., Athens). Dec. 20, 1963. Contract AT(40-1)-2418. 22p.

Unirradiated Marlex 50 polyethylene and polybutene-1 films were each melted in new heated cells to study the effects of melting and resolidification on their infrared spectra. Crystalline and amorphous bands were identified. The G value for trans-vinylene growth in polybutene-1 during irradiation was found to be approximately 0.30. The effect of melting crystalline polymer films is to reduce the intensity of the out-of-plane hydrogen deformation band of vinyl, trans-vinylene, and vinylidene olefins. These intensity reductions are too large to be ignored in calculating double bond concentrations. In melting the crystallites in irradiated polymers, it is imperative to prevent oxidation by heating the film in an oxygen-free atmosphere. New cells built for this purpose, containing a helium atmosphere, have not been successful thus far in preventing all oxidation. A study on the infrared spectra of polybutene-1 before and after gamma irradiation was completed. It was concluded that polybutene-1 has two crystalline forms, but the third crystalline form reported by Zannetti et al failed to exhibit infrared bands not found in the other two forms. X-ray diffraction spectra have been scanned on these three forms. The x-ray spectra of forms I and II agreed fairly well with those reported by Zannetti et al, but the spectra for form III differed widely from theirs. The x-ray spectra indicated that form III probably contains some of forms I and II, but other new lines have been observed also in form III. In addition to forming different types of double bonds, irradiation of polybutene-1 apparently melted all crystallites. A survey was made of the growth and decay of double bonds observed in the polymers studied. The specific structural and environmental polymer characteristics favoring growth and/or decay of specific olefin groups is still very elusive in spite of the many polymers studied. (auth)

34221 ISOTHERMAL MEASUREMENTS ON THE RELEASE OF STORED ENERGY FROM REACTOR-IRRADIATED AND COLD-WORKED MOLYBDENUM. H. U. Åstroem (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 26: 83-92(1964).

Specimens of molybdenum were irradiated with pile neutrons or cold-worked by compression. The stored energy release was studied isothermally in the temperature range of 75 to 186°C. For the irradiated specimens two annealing stages are observed, one below 100°C and one at about 180°C. The apparent values of the energy of activation for these stages are 0.4 ev and 0.8 ev respectively. These values are considered to be too low because of trapping of the point defects. The stored energy release is about 50 cal/mole for molybdenum irradiated with 10^{17} fast neutrons/cm^2 at 35°C. The time dependence for the energy release is purely exponential in the whole temperature range considered. The recovery in the cold-worked material is governed by a hyperbolic time dependence for the rate of change of energy release of the same character as has been found earlier for recovery in deformed f.c.c. metals. The stored energy release is 2.6 cal/mole between 98 and 186°C for 40% compressed molybdenum. The energy of activation determined for the process is 1.5 ev in the range of 80 to 98°C. (auth)

34222 RESTORATION OF THE ELECTRICAL RESISTIVITY OF VERY PURE ALUMINUM IRRADIATED BY NEUTRONS AT 77°K. Colette Frois and Omourtague Dimitrov. Compt. Rend., 258: 5647-50(June 8, 1964). (In French)

A study was made on zone-fused Al to determine if the faults induced by neutron irradiation at 77°K could be eliminated at temperatures below 190°K. The Al wire samples were irradiated liquid nitrogen tubes. The duration and dose of irradiation and the increase in resistivity are tabulated. The irradiated wires were annealed at increasing temperatures from 80 to 300°K for a total anneal time of 60 min. The curves on the variation of the electrical resistivity excess as a function of the annealed temperature show two principal stages for the elimination of radio-induced faults. The first stage is of less importance than the second. The position of the second stage depends on the irradiation dose and is displaced toward lower temperatures when the dose increases. A mean value of 0.56 ± 0.06 ev was found for the activation energy for the second maximum. (J.S.R.)

34223 PRACTICAL RADIATION TESTING. Arnold Pollack (Aerotest Labs., Deer Park, N. Y.). Environ. Quart., 9: No. 3, 28-35(Sept. 1963).

Requirements for test engineers to function in radiation environments are discussed. They include: developing an "in-house" expert with knowledge of radiation, dosages, and exposure times; selection of testing materials; selection of testing laboratory for material and operational tests; and accelerated testing. Characteristics of radiation environments are also discussed. (L.B.S.)

34224 THE EFFECT OF FAST-NEUTRON IRRADIATION ON BERYLLIUM OXIDE COMPACTS AT HIGH TEMPERATURES. G. W. Keilholtz, J. E. Lee, Jr., and R. E. Moore (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 11: 253-64(Apr. 1964).

The effect of fast neutron irradiation on beryllium oxide at high temperatures was investigated. Cylindrical compacts were irradiated over the fast-neutron dose range 1.2 to 3.65×10^{21} nvt at temperatures ranging from 583 to 1100°C, and 35 of 48 specimens survived intact. Volume increases varying from 0.9 to 4.4% were observed. Hot-pressed samples expanded more than cold-pressed and sintered samples under similar conditions. Fracturing and volume expansion generally increased with increasing fast neutron dose and decreased with increasing temperature. There was a loss of about 60% in crushing strength, but it was not possible to correlate this loss quantitatively with temperature or neutron dose. A decrease in thermal conductivity of 25 to 55% depending on the neutron flux was indicated by in-pile ΔT measurements. Grain-boundary separation can account for most of the changes in physical properties observed. The hot-pressed samples appeared to have undergone more extensive grain-boundary separation than the cold-pressed samples; this correlates with their greater volume increases. In BeO compacts exposed to low neutron doses at very low temperature (~100°C), grain-boundary separation is primarily caused by anisotropic expansion of BeO crystals. Lattice-defect agglomeration and lattice-parameter expansion both contribute to a preferential growth in the direction of the axis in the BeO crystals. The data indicate, however, that the lattice expansion continues to be proportional to the fast neutron dose up to 3.6×10^{21} nvt. (P.C.H.)

34225 THE EFFECT OF IRRADIATION ON THE MICROSTRUCTURE OF HOT-PRESSED BeO. H. J. Woollaston and R. S. Wilks (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 11: 265-72(Apr. 1964). (AERE-R-4404)

Milford Haven hot-pressed BeO was irradiated in DIDO at 150°C to doses in the range $2.4 \times 10^{19} - 1.7 \times 10^{20}$ nvt ≥ 1 Mev. It was examined, before and after irradiation, by optical microscopy and replica electron microscopy. Before and after irradiation, negative crystal pores and small pores (0.02 – 0.1 μ diameter) are present. There is no evidence of the formation of helium bubbles even after annealing at temperatures up to 1500°C. A little cracking was seen by optical microscopy in large grain size BeO, but not in small grain size BeO before irradiation. After irradiation more cracking was visible, and it increased with the dose received by the specimen. The effect on the cracking of annealing at temperatures up to 1500°C was studied. The results were in general accord with theoretical expectations. (auth)

34226 ELECTRON MICROSCOPY OF IRRADIATED BeO. Robert C. Rau (General Electric Co., Cincinnati). J. Nucl. Mater., 11: 320-32(Apr. 1964).

Electron microscopy was used to study the effects of nuclear irradiation on the microstructure of sintered BeO. The effects observed can be grouped into two categories, grain boundary separation, and gas bubble formation. Grain boundary separation occurs during low-temperature (~100°C) irradiations and was correlated with orientation of the grains comprising the sample. This separation, caused by the anisotropic lattice expansion of irradiated BeO, is quite noticeable in specimens with randomly oriented grains, and is less common in specimens exhibiting a preferred orientation. High-temperature irradiation produces little grain boundary separation because of thermal annealing effects. Gas bubbles, consisting of helium and tritium, are formed during high-temperature irradiations of BeO, and were observed to occur chiefly at grain boundaries. Both pre-irradiation density and grain size have an effect on bubble formation in high-temperature irradiated BeO. Bubbles are less abundant in low-density specimens, which contain many sintering pores to absorb the gas, than in high-density specimens, which contain few pores. The size and abundance of gas bubbles noticeably

increases with increasing grain size of the BeO. This effect is related to the amount of available grain boundary surface area over which the gas may be distributed. Intragranular stringer-type formations, possibly composed of gas bubbles, were seen in the microstructure of high-temperature irradiated BeO after etching. (P.C.H.)

34227 CALORIMETRY AT HIGH TEMPERATURE. APPLICATION TO THE DETERMINATION OF THE RECOVERY ENERGY OF BeO IRRADIATED WITH NEUTRONS. André Roux, Marc Richard, Lucien Eyraud, and Jean Elston (Commissariat a l'Energie Atomique, Lyon). J. Phys. (Paris), 25: Suppl. to No. 3, 51A-6A(Mar. 1964). (In French)

The Wigner energy of BeO irradiated with fast neutrons at temperatures below 100°C was measured at temperatures to 1200°C, using a compensated calorimetric method. The results show that the energy varies strongly with the rate of irradiation. The calorimetric method is described, and the results are presented. (D.C.W.)

34228 EFFECTS OF DOSAGE AND IMPURITIES ON RADIATION DAMAGE OF CARRIER LIFE TIME IN Si. Takano Nakano and Yoshio Inuishi (Osaka Univ.). J. Phys. Soc. Japan, 19: 851-8(June 1964).

To clarify several points, radiation damage and its annealing process in various kinds of Si crystals were investigated by measuring the change in minority carrier lifetime with microwave absorption method. Both irradiation dose rate and total dose have a remarkable effect on annealing behavior of carrier lifetime. For example annealing temperature increases remarkably with increasing total dose of irradiation. These behaviors are also found in the annealing of A-center measured by Hall effect. The radiation damage and annealing process of lifetime were found to be very sensitive to the impurities such as O, Fe, Ni, and Cu. The depth of the recombination and trap levels and their cross sections were estimated from temperature dependences of lifetime and of thermal release time in various kinds of Si crystals. (auth)

34229 INFLUENCE OF GAMMA IRRADIATION ON INTENSIFICATION OF ANNEALING OF MALLEABLE CAST IRON. V. A. Shalashov. Liteinoe Proizv., No. 12, 20-2(1963). (In Russian)

White malleable cast iron was gamma irradiated in vacuum at 800 and 70°C. Determination was made of the influence of irradiation, temperature and Cr content in cast iron on graphite form, graphitization rate, and microstructure by comparison with control specimens. (Rev. Metal Lit., 21: (June 1964))

34230 REMOVAL OF RADIATION DAMAGE FROM GRAPHITE BY ALTERNATE REIRRADIATIONS AND LOW-TEMPERATURE ANNEALS. Donald G. Schweitzer and Robert M. Singer (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 19: 385-9(Aug. 1964). (BNL-7785)

The dimensional expansion during a reirradiation and the contraction during an anneal were studied as functions of irradiation temperature, anneal temperature, total damage, and exposure between anneals. The results show that alternate reirradiations and anneals can be used to remove radiation damage from graphite. The recovery for an annealing and reirradiation cycle is independent of irradiation temperature between 30 and 200°C and total damage over wide ranges. The reciprocal of the recovery/cycle is a linear function of the exposure between anneals with a shape that is determined by the anneal temperature. (D.C.W.)

34231 RADIATION-INDUCED DIMENSIONAL CHANGES IN LARGE GRAPHITE BARS. R. E. Nightingale and E. M. Woodruff (General Electric Co., Richland, Wash.). Nucl. Sci. Eng., 19: 390-2(Aug. 1964). (HW-SA-2996)

The effects of neutron irradiation at high temperatures on the dimensions of small cylindrical samples and large bars were investigated. The contraction of the large bars was approximately twice that of the cylindrical samples. The effect appears to be associated with variations in anisotropy within the large bars. (D.C.W.)

34232 RADIATION EFFECTS ON PYROLYTIC GRAPHITE. H. H. Yoshikawa (General Electric Co., Richland, Wash.). Nucl. Sci. Eng., 19: 461-2(Aug. 1964).

Specimens of pyrolytic graphite with a density of 2.20 g/cm^3 were irradiated at about 650°C for two successive neutron exposures. The dimensional changes in the second irradiation were obtained as a function of exposure, and changes in the lattice parameters were determined. The dimensional changes indicate that the effect of irradiation is exactly the reverse of the effect of heat treatment on bulk dimensions. The implications of the observations for radiation effects in polycrystalline graphite are considered. (D.C.W.)

34233 FATIGUE DESIGN BASIS FOR ZIRCALOY COMPONENTS. W. J. O'Donnell and B. F. Langer (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 20: 1-12(Sept. 1964).

The required basic strain-controlled data for both unirradiated and irradiated Zircaloy-2, -3, and -4 were obtained for temperatures between 70 and 600°F. Data are included both rolled and base-annealed material, and as-welded material tested in various directions. The cyclic stress-strain properties of these materials were also obtained and were found to differ quite significantly from the conventional properties. Using the cyclic properties in a Modified Goodman Diagram, fatigue-failure curves were developed which included the deleterious effect of the maximum possible mean stress that can exist in the material as it is cycled. Limited available test data confirm the validity of this method. The worst possible effects of residual stresses due to welding and other fabrication methods, and mean stresses due to differential thermal expansion are included in the curves. The phenomenon of fuel growth introduces a monotonically increasing strain which accompanies the cyclic strain. The effects of such a gradually accumulating increment of strain were investigated and were found to be adequately covered by the adjustment for maximum mean stress. Design curves were constructed from the mean failure curves by applying approximate factors to cover the effects of size, environment, surface finish and scatter of data. The results of fatigue tests on notched irradiated Zircaloy indicate that this material is somewhat less notch sensitive than 100,000-$lb/in.^2$ tensile strength steel. Unirradiated Zircaloy is even less notch sensitive. However, fatigue tests on notched weld metal indicate considerably greater notch sensitivity. (auth)

34234 SWELLING OF IRRADIATED URANIUM–ZIRCONIUM ALLOYS ON ANNEALING. B. A. Loomis (Argonne National Lab., Ill.). Nucl. Sci. Eng., 20: 112-13(Sept. 1964).

The swelling of irradiated U–Zr alloys on annealing at temperatures to 900°C was measured in terms of density change, and the effect of the annealing temperature on the release of fission-product gas was determined. The data show that phase changes influenced the swelling and gas release. (auth)

34235 THE EFFECT OF SPACE ENVIRONMENT ON MATERIALS. W. A. Wagner, D. J. Hamman, S. Palinchak, J. H. Stang, and F. R. Shober (Battelle Memorial Inst., Columbus, Ohio). Nucleonics, 22: 114-19(Aug. 1964).

The property changes that materials undergo as a result of cosmic electromagnetic and particulate radiation interactions in space as well as those resulting from the low pressures encountered in space and the consequent absence of a convective cooling mechanism are briefly outlined. Structural metals, semiconductors, ceramics, resistors, capacitors, piezoelectric crystals, transistors, elastomers, and plastics are considered. (C.E.S.)

34236 GAMMA HEATING IN REACTOR EXPERIMENTS. R. E. Schreiber and R. J. Allio (Westinghouse Electric Corp., Pittsburgh). Nucleonics, 22: 120-5(Aug. 1964).

The important sources of gamma heating in a material placed in or near the reactor core are discussed. A hand-calculation method for making a good estimate of the gamma heat generation in in-pile experiments is presented. The method includes primary gamma flux calculations, secondary gamma flux calculations, and heat generation calculations. (C.E.S.)

34237 THE EFFECT OF FAST NEUTRONS ON THE THERMOELECTRIC PROPERTIES OF SEMICONDUCTORS. Nguyen Van Dong (Centre d'Études Nucléaires, Saclay, France). Onde Elec., 43: 1260-6(Dec. 1963). (In French)

The effects of neutron irradiation (up to doses of $1.2 \times 10^{18}/cm^2$) and annealing on the thermal conductivity, thermoelectric power, and the concentration and mobility of free carriers in germanium and silicon were investigated. Notably, the thermal conductivity and charge carrier mobility were reduced by irradiation. The effect of fast neutrons on the figure of merit of thermoelectric materials for use in direct energy conversion is also discussed. (D.C.W.)

34238 RADIATION EFFECTS AND THEIR ANNEALING IN Co^{60}-GAMMA-IRRADIATED Sb-DOPED GERMANIUM. J. C. Pigg and J. H. Crawford, Jr. (Oak Ridge National Lab., Tenn.). Phys. Rev., 135: A1141-50(Aug. 17, 1964).

The annealing of changes in the electric properties of antimony-doped germanium caused by ^{60}Co gamma irradiation at 77°K was investigated by both isochronal and isothermal techniques. The previously observed levels at 0.2 ev below the conduction band and near or below the middle of the forbidden band were studied individually. It was found that both the rate of carrier removal and the subsequent course of recovery upon annealing above 273°K were markedly dependent upon the antimony concentration (N_{Sb}). The rate of electron removal ($dn/d\phi t$) is smaller for lower antimony concentrations. Upon annealing in the range between 273 and 450°K, two distinct stages are observed. Stage A accounts for the major recovery of the change in carrier concentration for samples with high antimony concentration ($N_{Sb} = 10^{15}\ cm^{-3}$) and for the major recovery of reciprocal mobility for both high- and low-purity material. By contrast, the major recovery of carrier concentration for the low antimony concentrations ($N_{Sb} \approx 10^{14}\ cm^{-3}$) occurs in the high-temperature stage, stage B. Stage B proceeds with an apparent activation energy of ~1.2 ev. The annealing data are considered in terms of a model in which the formation of antimony-vacancy and antimony-divacancy complexes occurs as parallel processes to vacancy capture by sinks. A new energy level at 0.09 ev below the conduction band was observed after annealing at 370°K. The level was tentatively attributed to oxygen-vacancy complexes. (auth)

34239 NEW OXYGEN INFRARED BANDS IN ANNEALED IRRADIATED SILICON. J. W. Corbett, G. D. Watkins, and R. S. McDonald (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 135: A1381-5 (Aug. 31, 1964).

Infrared and electron-spin-resonance measurements on the recovery of silicon irradiated with 1.5-Mev electrons are presented. In the infrared measurements the disappearance of the previously report 829-cm^{-1} (12μ) oxygen vibration band is followed, and the appearance and subsequent disappearance of a succession of new infrared bands are observed. The major new bands are at 887, 904, 968, and 1000 cm^{-1}, although others are also found. Tentative defect models are proposed to account for the recovery features. (auth)

34240 ORIENTATION DEPENDENCE OF ELECTRON RADIATION DAMAGE IN InSb. F. H. Eisen (North American Aviation, Inc., Canoga Park, Calif.). Phys. Rev., 135: A1394-9(Aug. 31, 1964).

The damage rate in (111)-oriented samples of InSb was measured with the (111) face perpendicularly exposed to the incident electron beam and with the $(\bar{1}\bar{1}\bar{1})$ face similarly exposed. When the damage is separated into the portion which recovers in stage I and that which recovers in stage II, it is found that the defects which annihilate in stage II are produced at lower energies than those annihilating in stage I. Also, the defects annihilating in stage II are produced at a higher rate in samples with the (111) face exposed to the electron beam than in samples with the $(\bar{1}\bar{1}\bar{1})$ face exposed. The production rate of defects annihilating in stage I is higher when the $(\bar{1}\bar{1}\bar{1})$ face is exposed to the beam. These data are interpreted in terms of the polarity of the InSb lattice in the ⟨111⟩ direction to show that the defects which annihilate in stage I are produced by the displacement of antimony atoms with a threshold displacement energy lying between 8.5 and 9.9 ev, and the defects which annihilate in stage II are produced by the displacement of indium atoms with a threshold displacement energy of about 6.4 ev. It is also possible to conclude that the likely direction of the minimum displacement energy in InSb is the ⟨111⟩ direction. (auth)

34241 CHANGES OF CRYSTAL STRUCTURE OF AN OXIDE, CARBONATE, AND TITANATE BY NEUTRON IRRADIATION. O. Hauser and M. Schenk (Zentralinstitut für Kernforschung, Rossendorf, Ger.). Phys. Status Solidi, 6: 83-8(1964). (In German)

The influence of neutron irradiation on crystal structure was investigated for a special class of materials. The materials have thermal crystalline phase transformations, which have been called displacive or reconstructive for first or second coordination, respectively. The maximum neutron dose is 2×10^{20} nvt ($\approx 2.8 \times 10^{19}$ fast neutrons/cm^2, neutron energy ≥ 1 Mev). For the materials examined $BaTiO_3$ shows a radiation induced phase transformation, and this is of the form tetragonal → cubic whereas in brookite and quartz a nearly quasi-amorphous phase occurs. The other materials exhibit no radiation induced transformation. These results are compared with other published data. It appears that compounds with thermal displacive transformations are more likely to suffer a radioinduced phase transformation than compounds with reconstructive transformations. (auth)

34242 EFFECT OF X-RAY IRRADIATION ON THE SHAPE OF THE DIELECTRIC HYSTERESIS LOOP IN

TRIGLYCINE SULFATE. T. Rewaj (Technical Univ., Szczecin, Poland). Phys. Status Solidi, 6: 163-8(1964).

Modifications were observed in the shape of the hysteresis loop of triglycine sulfate $[(NH_2CH_2COOH)_3 \cdot H_2SO_4]$ single crystals due to x irradiation. For radiation doses up to 13 MR and a-c fields amplitude up to 35.2 kv cm^{-1}, the characteristic double loop was always observed. Non-uniform irradiation of the specimen was found to produce a distortion of the hysteresis loop which depends on the degree of non-uniformity. (auth)

34243 INVESTIGATION OF THE EFFECT OF IONIZING RADIATION ON THE STRUCTURE OF POLYPROPYLENE. N. A. Slovokhotova, Z. F. Il'icheva, L. A. Vasil'ev, and V. A. Kargin (Karpov Scientific Research Inst. of Physical Chemistry, [Academy of Sciences,] USSR). Vysokomolekul. Soedin., 6: 608-14(1964).

The results of an investigation by infrared spectroscopy on the structural changes produced in polypropylene by ionizing radiation are reported. Film of isotactic and commercial amorphous polypropylene was prepared by hot pressing, then irradiated in vacuo at room temperature and at liquid nitrogen temperature with fast electrons on an electron accelerator tube and with ^{60}Co gamma radiation. The spectrum of irradiated polypropylene showed absorption bands in the 1645 and 890 cm^{-1} region corresponding to vinylidene groups; in the 735-740 cm^{-1} region corresponding to propyl branches; and in the region of 910 cm^{-1} corresponding to vinyl groups. In the 1665 cm^{-1} region there were absorption bands characteristic of internal double bonds. The conjugation of a double bond with an unpaired electron in the allyl radical was found to affect the frequency of the valence fluctuation of the double bond. The effect of the phase state of the polymer and the irradiation temperature, and the mechanism involved in the degradation and cross-linking of polypropylene during irradiation are discussed. (OTS)

34244 INVESTIGATION OF THE KINETICS OF DECOMPOSITION OF ALUMINUM–MAGNESIUM ALLOYS AFTER NEUTRON IRRADIATION. Klaus Detert and Ludwig Thomas (Technische Universität, Berlin). Z. Metallk., 55: 343-7(June 1964). (In German)

Aluminum–magnesium alloys with 6 to 12 wt % Mg were exposed in a reactor to a maximum neutron flow of 6×10^{16} cm^{-2} at liquid nitrogen temperature. The change in resistivity of the samples was measured at aging temperatures between –30 and +30°C and up to 250 hours. The irradiation caused an acceleration at the beginning of aging and a retardation during the later stages. The resistivity change can be explained by the assumption that the number of vacancies as well as the number of vacancy sinks is increased during irradiation, so that the supersaturated vacancies can anneal out at a high rate. (auth)

34245 RADIATION EFFECTS HANDBOOK. Sponsored by Radiation Technology Subcommittee of the IEEE Nucleonics Committee, Radiation Effects Subcommittee of the IEEE Electrical Insulation Committee. J. R. Bilinski and W. R. Langdon, eds. New York, Institute of Electrical and Electronics Engineers, Inc., 1963. 96p. $3.00.

Discussion and data are given on radiation effects on: matter; encapsulating, potting, and structural plastics; laminates composed of inorganic fillers and various organic binders; laminates composed of various fillers and phenol formaldehyde resin; highly crosslinked resins; thermoplastic resins; liquid and specific dielectrics; plastic films and sheets; paints, varnishes, and other coatings; engineering adhesives; and capacitors. (P.C.H.)

34246 EFFECT OF THE LATTICE ORIENTATION ON THE CHANNELLING OF FAST NEUTRONS THROUGH $SrTiO_3$ SINGLE CRYSTALS. H. Weik (Univ. of Cincinnati). 12p. (CONF-481-72)

From American Physical Society Annual Meeting, New York, Jan. 1964.

The effect of bombarding single crystals of $SrTiO_3$ with fast neutrons was investigated. It was found that bombardment changes the symmetry of the lattice and produces a polarization of the crystal, the magnitude of the effects depending on the direction of bombardment. Bombarding the crystal in the ⟨100⟩ direction had a larger effect on both the lattice distortion and the polarization than bombarding in the ⟨100⟩ direction. An attempt was made to explain the effects on the basis of the stopping power concept for the channeling of neutrons through a lattice. (auth)

34247 EFFECTS OF NUCLEAR RADIATION AND CRYOGENIC TEMPERATURES ON ENGINEERING MATERIALS. E. C. McKannan and R. L. Gause (National Aeronautics and Space Administration, Huntsville, Ala.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-361, 19p. $1.00. (CONF-600-19)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The results of an investigation of the effects of nuclear radiation and cryogenic temperatures on some structural adhesives and laminates, thermal insulations, thermal control coatings, and electrical insulation under consideration for use in nuclear-powered spacecraft are presented. (D.C.W.)

34248 STUDIES OF RADIATION DAMAGE IN SILICON AVALANCHE DIODES. R. Haitz (Clevite Corp., Palo Alto, Calif.), R. Gereth, and F. M. Smits. 8p. (CONF-543-7)

From American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964.

A new method that allows studies of radiation damage within volumes of less than 10^{-11} cm^3 is described. The method was used to detect the permanent radiation damage induced by a single neutron collision in a silicon avalanche diode. It was found that exactly one primary neutron collision occurred in 60% of the diodes studied with an increased pulse rate. (P.C.H.)

34249 POINT DEFECT STUDIES IN GOLD BY ELECTRON IRRADIATION AT LOW TEMPERATURES. II. THE RESISTIVITY RECOVERY SPECTRUM FROM 15°K TO 240°K. Walter Bauer and A. Sosin (Atomics International, Canoga Park, Calif.). 36p. (CONF-23-24)

From American Physical Society, 1963 March Meeting, St. Louis, Mar. 1963.

The resistivity recovery of 99.999% pure gold after 2-Mev electron irradiation near 13°K was studied. Combining the observations on the dependence of the recovery on the concentration of defects with some simple calculations and other relevant experimental results, the following conclusions were reached. In the temperature range from 15 to 50°K, the recovery consists of a spectrum of processes characterized by first order kinetics and therefore no random vacancy-interstitial recombination with a measurable resistivity decrease takes place. In the temperature range from 50 to 240°K, the recovery is almost continuous; long-range migration of defects is not likely. Most of the resistivity recovery of Au between 15 and 240°K after electron irradiation is attributed to the non-random recombination of Frenkel pairs. (auth)

METEOROLOGY

34250 (AWRE-O-35/64) V.L.F. PHASE ANOMALIES ASSOCIATED WITH HIGH ALTITUDE NUCLEAR EXPLOSIONS. F. L. Hill (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). [1963]. 12p.

A phase anomaly associated with Starfish is discussed. Account is taken of the height at which electrons of differing energies produce their maximum ionization. This results in improved agreement between predicted and observed effects. (auth)

34251 DETECTION AND IDENTIFICATION OF NUCLEAR BURSTS. H. M. Epstein and R. W. Klingensmith. Battelle Tech. Rev., 13: No. 8, 3-9(Aug. 1964).

Characteristics of, and possible techniques for detecting nuclear bursts are reviewed. It is reported that probabilities of detecting and identifying atmospheric and near-space bursts are good. Some on-site inspection techniques are listed. (P.C.H.)

34252 ANOTHER POSSIBLE EXPLANATION OF SUDDEN ATMOSPHERIC IONIZATION IN REGIONS SHADOWED FROM HIGH-ALTITUDE NUCLEAR BURSTS. A. Foderaro (Pennsylvania State Univ., University Park). J. Geophys. Res., 69: 3137-40(Aug. 1, 1964).

Sudden changes in v-l-f propagation characteristics, presumably due to increased D-layer ionization, were observed to occur along v-l-f- paths the nearest points of which lie thousands of kilometers away from a high-altitude nuclear burst. It is proposed that this ionization may be caused by neutrons that were transported by multiple scatterings around the earth and well into the shadow zone where they deposit part of their kinetic energy through collisions with nitrogen nuclei. Numerical results are presented, based on a highly simplified model The possibility of experimentally distinguishing between the transport mechanism and the neutron decay mechanism is also discussed. (auth)

34253 SATELLITE SIGNAL FLUCTUATION CAUSED BY IONOSPHERIC IRREGULARITY. William C. Meecham (Space Tech. Labs., Inc., Los Angeles and Univ. of Minnesota, Minneapolis). J. Geophys. Res., 69: 3175-85(Aug. 1, 1964).

The quantitative characteristics of amplitude fluctuations observed in signals (u-h-f and v-h-f) received from Explorer 6 are reported. The signal noise has a correlation time of the order of 0.25 sec and is modulated by two discernible satellite rotations. The power spectrum function is calculated. The probability distribution for the signal amplitude is found, and from this the ratio (about 0.4) of the incoherent noise to the coherent signal is determined. It is proposed that the signal fluctuations are probably caused by fluctuations in electron density in the F layer of the ionosphere. A conjecture is offered that turbulence-generated sound, which was measured at altitudes of 20 km, may propagate into the lower ionosphere before being quenched by viscous effects, causing the electron density fluctuations. (auth)

34254 THE CONTRIBUTION OF NONTHERMAL ELECTRONS TO AURORAL ABSORPTION OF RADIO WAVES. George C. Reid (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 69: 3296-8(Aug. 1, 1964).

It is shown that the contribution of nonthermal electrons to the total absorption observed during auroral events is probably not negligible and may be observable. (D.C.W.)

34255 FURTHER EXAMPLES OF THE USE OF LONG-LIVED NUCLEAR PRODUCTS IN THE STUDY OF LARGE-SCALE ATMOSPHERIC MOVEMENTS. Adriano Gazzola. Riv. Meteorol. Aeronaut., 24: No. 2, 35-49(1964). (In Italian)

The use of long-lived nuclear products as tracers in the study of large-scale atmospheric movements is illustrated with a few examples. The β activity of the air measured at U. S. stations was analyzed with respect to the Russian nuclear explosions starting September 1, 1961. The movement of a large radioactive cloud in the lower atmospheric layer of this region was examined for the period Sept. 17 to Sept. 23. The displacement of its central core was related to currents at 1000 m. The isopleths of the radioactivity plotted on fixed alignments and the evolution of the pressure and frontal situation at ground level were examined. It was concluded that in the lower atmosphere the air exchanges along the medians are made prevalently by lateral diffusion at the scale of mobile pressure systems. (tr-auth)

34256 ATMOSPHERIC ATTENUATION OF THERMAL RADIATION FROM A HIGH-ALTITUDE NUCLEAR DETONATION. Reynold Atlas and B. N. Charles (Boeing Co., Seattle). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-318, 10p. $1.00. (CONF-600-20)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

Atmospheric attenuation is discussed in relation to transmission of thermal radiation from high-altitude nuclear explosions. The usefulness of solar radiation transmission data for determining the thermal transmission properties of the atmosphere is considered in some detail. Horizontal visibility in not a generally valid indicator of atmospheric transmissivity through vertical or slant paths. If the weapon emission spectra are comparable to that of the sun, frequency distributions of atmospheric transmissivity for solar radiation can be used to estimate the area vulnerable to mass fires. (D.C.W.)

34257 TECHNIQUES OF DETERMINING RADON CONCENTRATION IN AIR NEAR THE GROUND. Charles R. Hosler (Weather Bureau, Washington, D. C.), Luther B. Lockhart, Jr., and Warren P. Dewitt. 19p. (CONF-625-1)

From American Meteorological Society 228th National Meeting, Washington, D. C., Apr. 1964.

The feasibility of using the natural radioactive isotopes, attached to submicron aerosol, as tracers of atmospheric diffusion processes near the ground was determined. A beta counting scheme based on a 20 min filtration period was used. The method provides a measure of the RaB activity in the air, which, for the most part, is proportional to the radon activity in the air. Observed radon concentrations near the ground were relatively high during inversion conditions, low during unstable conditions. The vertical profile of radon concentration, and thus derived vertical diffusion coefficients, appear to reflect the vertical mixing that occurs near the ground. (P.C.H.)

PHYSICS

General

34258 (AD-417250) INVESTIGATION OF DENSITY EFFECT IN SOLIDS AND GASES. Final Technical Report. (Paris. Université, Orsay. Ecole Normale Supérieure. Laboratoire de l'Accélérateur Linéaire). [nd]. Contract DA-91-591-EUC-2011. 116p.

The results of several experiments are reported. The first experiment was designed to test the importance of radiative corrections to Cerenkov radiation, which have been invoked to explain the difference observed between the Fermi theory of specific energy loss and the blob density in photographic emulsions. This measurement (in hydrogen gas) demonstrated the complete absence of the radiative correction, since the observed pressure dependence was explained entirely by the Fermi theory. No explanation for the discrepancy exists. The second experiment measures the ionization produced by 150-Mev electrons in hydrogen–helium mixtures as a function of the relative concentrations. The aim of the experiment is to see whether the Cerenkov radiation photons from helium ionize the hydrogen atoms. The results agree with a theory including the reabsorption of the Cerenkov radiation, contrary to the classical theory prediction that the energy loss to Cerenkov radiation is included in the Fermi formula. The third subject is a summary of data on secondary emission monitors obtained at various laboratories, confirmed and supplemented by measurements at Orsay. An explanation is offered of frequently observed instabilities as being due to the Malter effect on the oxidized surfaces. Methods of eliminating instabilities are proposed and tested. An explanation of the energy dependence of the secondary emission efficiency is proposed which renders good account of the phenomena and leads to a possible velocity-dependent detector of highly relativistic particles. The fourth experiment is on electron-positron pair production by 150-Mev electrons. The measurements extend to 140 Mev and show good agreement above 100 Mev with the calculations while confirming that experiment is lower than theory at lower energies. The fifth experiment investigates the Landau straggling curve and the density effect in solid metallic targets. The results show agreement (1%) for the most probable energy loss for all the targets studied, thus verifying the calculated density effect. The straggling curve is reasonably well verified for the heavy elements if due account is taken of resonant energy transfers. For light elements a discrepancy of 15% for the width exists. This may indicate that a modification of the Bethe-Heitler formula for low energy bremsstrahlung loss is necessary. The results lead to a method of calculating the line shape in electron scattering experiments. (auth)

34259 (AD-434907) RECOMBINATION OF MOLECULAR POSITIVE IONS WITH ELECTRONS. Technical Report No. 3. M. A. Biondi, T. R. Connor, C. S. Weller (Pittsburgh. Univ.), and W. H. Kasner (Westinghouse Electric Corp. Research Labs., Pittsburgh). Apr. 1964. Contract Nonr-624(13)-NR-012-114. 32p. (APP-5)

Results of studies of the recombination of electrons with molecular positive ions are presented. Theoretical arguments indicate that the dissociative process — in which a molecular ion captures an electron without change of energy, forming an unstable excited molecule which then dissociates — provides a highly efficient recombination mechanism. The nature of the process responsible for the large recombination rates observed in laboratory afterglow studies is investigated using combined microwave, optical spectrometric and interferometric, and mass spectrographic techniques. Dissociative recombination is shown to be the process operative in the laboratory studies, since it is found that (a) molecular positive ions must be present to observe a large recombination rate, (b) when diatomic ions are present, excited atoms are formed in the recombination process, and (c) these excited atoms have kinetic energy of dissociation substantially in excess of thermal energy. Under conditions where the electrons, ions, and gas are all at the ambient temperature, T = 300°K, the two-body recombination coefficients for mass-identified Ne_2^+, N_2^+, O_2^+, and NO^+ ions are all somewhat in excess of 10^{-7} cm^3/sec. The more complex polyatomic ion N_4^+ exhibits a rather larger (~10^{-6} cm^3/sec) recombination coefficient. The dissociative recombination rates may exhibit a variety of temperature dependences, depending on the details of the potential curves describing the molecular states involved in the process, and the little available experimental evidence indicates substantially different variations with electron temperature for different ions. It is concluded that diatomic ions involved in combustion processes may exhibit recombination coefficients of the order of 10^{-7} cm^3/sec at 300°K, and the coefficients may decrease with increasing temperature. More complex polyatomic ions may exhibit larger recombination coefficients, but the evidence concerning their behavior is meager. (auth)

34260 (AD-601933) NUCLEAR MAGNETIC RESONANCE IN SOLID H_2 AND D_2 UNDER HIGH PRESSURES. Technical Report No. 3. Samuel A. Dickson and Horst Meyer (Duke Univ., Durham, N. C.). [1964]. Contract Nonr-1181(12). 46p.

Nuclear magnetic resonance data are presented for solid H_2 and D_2 between 1.5 and 4.2°K and at pressures up to 5500 atm. For solid hydrogen, the ortho-para conversion, the transition temperature T_λ from the state of free rotation to that of hindered rotation, and the line-width and second moment above T_λ were measured as a function of density ρ and ortho concentration. The ortho-para conversion rate is approximately proportional to $\rho^{2.4}$, and the transition temperature T_λ for a given ortho concentration is roughly proportional to $\rho^{2.0}$. These results are compared with other experimental evidence and with theoretical expectations. The second moment for both H_2 and D_2 (the latter with an ortho concentration of 0.67) is compared to that calculated for dipole-dipole interaction in a rigid lattice having the structure and dimension determined from x-ray and neutron data. The experimental second moments are found to be larger than the calculated ones, and the discrepancy is discussed. (auth)

34261 (AEDC-TDR-64-127) ANALYTICAL AND EXPERIMENTAL STUDIES TO DEVELOP ION ENGINE GROUND TESTING TECHNIQUES. R. A. Hubach (Hughes Aircraft Co. Hughes Research Labs., Malibu, Calif.). June 1964. Contract AF40(600)-948. 72p.

Investigations of the interaction of an annular ion beam with its environment in ground test facilities were performed to establish those conditions which best approximate the environment encountered in space. Techniques

to investigate the degree of interaction and probes to infer specific parameters of the beam were developed. Special emphasis was placed on the neutralization problem. (auth)

34262 (AFCRL-64-284) INFRA-RED ABSORPTION OF HYDROGEN AND DEUTERIUM IONS IN CALCIUM FLUORIDE. Scientific Report No. 4. W. Hayes, G. D. Jones, R. J. Elliott, and C. T. Sennett (Oxford Univ. Clarendon Lab.). Jan. 30, 1964. Contract AF61(052)-677. 9p. (AD-435616)

An investigation has been made of the localized vibrations of hydrogen and deuterium ions present as impurities situated on the fluorine sites in calcium fluoride. (auth)

34263 (ANL-6826) DOSIMETRY FOR RADIATION DAMAGE STUDIES. A. D. Rossin (Argonne National Lab., Ill.). Mar. 1964. Contract W-31-109-eng-38. 20p.

A method is presented for reporting fast-neutron exposure in a meaningful and unambiguous fashion. The steps involve determination of spectrum shape, absolute magnitude, an energy weighting for the neutrons, and a unit for reporting exposure. Various methods for performing the procedure are described, and the reasoning behind the approach is explained. (auth)

34264 (ARL-63-175(Pt.II)) A CRITICAL SURVEY OF MAGNETOFLUID DYNAMICS. PART II. MAGNETOHYDRODYNAMIC CHANNEL FLOWS. Shih I. Pai (Maryland. Univ., College Park). Mar. 1964. Contract AF33(657)-7805. 54p.

A critical survey of the flow of an electrically conducting liquid in a pipe or channel under the influence of a transverse electromagnetic field is given. The fundamental principles on which the analysis of the magnetohydrodynamic (MHD) channel flow is based are discussed. Various MHD channel flows that contain the generalized Hartmann flow, laminar flow in pipes, unsteady flow, and turbulent flow are analyzed in detail. The present knowledge of MHD channel flow is summarized, and recommendations for future research are made. (auth)

34265 (BNL-7320) AN INVESTIGATION OF THE LOW-FREQUENCY MOTIONS IN ISOTACTIC AND ATACTIC POLYPROPYLENE BY NEUTRON INELASTIC SCATTERING. G. J. Safford (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.); H. R. Danner (Brookhaven National Lab., Upton. N. Y.); H. Boutin (Picatinny Arsenal, Dover, N. J. and Brookhaven National Lab., Upton, N. J.); and M. Berger (Esso Research and Engineering Co., Linden, N. J.). [1963]. Contract [AT (30-2)-Gen-16]. 26p.

The vibrational spectra between 1000 and 30 cm^{-1}, derived from measurements of the inelastic scattering of cold neutrons, are presented for isotactic polypropylene at sample temperatures below and above both the glass transition and the melting point. A tentative assignment of the observed modes is suggested by comparison with recent calculations by Miyazawa, Ideguchi, and Fukushima of the optically active phases of the fundamental vibrations for an isotactic helical polypropylene chain and with the neutron measurements of the low frequency modes in highly crystalline polyethylene. In addition to the skeletal optical modes, the neutron spectra for isotactic polypropylene indicate the existence of two acoustic modes—skeletal deformation and skeletal torsion—with high frequency limits at 620 ± 50 cm^{-1} and 110 ± 10 cm^{-1}, respectively. As in polyethylene, these modes appear to be strongly influenced by the presence and phase of the disorder in the sample. Similar spectra for atactic polypropylene above and below the glass transition show a much less pronounced structure, although weak bands are observed which correlate well with the skeletal optical modes observed in the isotactic polymer. (auth)

34266 (CLM-R-31) COMPUTER PROGRAMS FOR THE NUMERICAL STUDY AND GRAPHICAL DISPLAY OF MAGNETIC FIELDS. F. M. Larkin (United Kingdom Atomic Energy Authority. Research Group. Culham Lab., Culham, Abingdon, Berks, England). Apr. 1964. 65p.

Six computer programs, which facilitate assessment of the plasma containment properties of a wide class of magnetic field configurations including magnetic mirrors, cusps, and Ioffe fields, are described. The programs can provide graphical output illustrating salient geometric features of the magnetic fields as well as printed output. This graphical output may be plotted automatically either on a Benson-Lehner Model J plotter or a Stromberg-Carlson 4020 microfilm recorder. All the programs were written in FORTRAN (52 dialect) for IBM 7030. A complete worked example is given for every program and data input is described in detail so that the report may be used as an operating manual for the programs. (auth)

34267 (D1-82-0331) ON THE STABILITY OF MHD CHANNEL FLOW. Flight Sciences Laboratory Report No. 88. F. D. Hains (Boeing Scientific Research Labs., Seattle). Mar. 1964. 28p. (AD-437808)

The stability equations are derived for MHD channel flow with aligned magnetic field. The equations are simplified in three limiting cases: (1) the interaction parameter N is very small, (2) the magnetic Reynolds number is very large, and (3) the magnetic Reynolds number is very small. (auth)

34268 (IFA-IS-27) ELECTRON SPIN RESONANCE OF THE Mn(II) ION IN ZEOLITES. I. Ursu and A. Nicula (Cluj. Universitatea "Babes-Bolyai"). [1964]. 13p.

Experimental and theoretical results are presented which were obtained in the ESR study of the Mn(II) ion in X and Y zeolites. An investigation was made of the behavior of this paramagnetic ion in various concentrations in the above mentioned zeolites and the verification of the spin Hamiltonian which describes the energetic state of the ion in crystalline fields of different symmetries. (auth)

34269 (JINR-P-1682) MNOZHESTVO RESHENII KRAEVOI ZADACHI DLYA NEKOTORYKH URAVNENII MATEMATICHESKOI FIZIKI. (Set of Solutions of a Boundary Value Problem for Certain Equations of Mathematical Physics). V. P. Shirikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 20p.

Investigations were made of the existence of the solutions of a certain boundary-value problem for the ordinary second-order nonlinear differential equations that appear in nonlinear field theory when studying elementary particle interactions, and in nuclear theory. Some properties of the solutions of this boundary-value problem are determined. (auth)

34270 (LAL-1093) L'IONISATION PRODUITE DANS DES GAZ PAR UN FAISCEAU D'ELECTRONS RELATIVISTES EN FONCTION DE LA PRESSION ET DE LA TEMPERATURE (these). (Ionization Produced in a Gas by a Beam of Relativistic Electrons as Functions of the Pressure and Temperature (thesis)). R. Morrison (Paris. Université). Jan. 1964. 80p.

The variation of the ionization with pressure was studied in hydrogen and with temperature in hydrogen and a mixture of 90% He–10% H_2. In introduction the various theories on the energy loss of high energy particles were in-

vestigated. The experimental methods are described. The results obtained in the pressure study using 155-Mev protons and 380-Mev electrons, and in the temperature study using alpha particles and 200-Mev electrons are reported. An interpretation is given of the results obtained. Supplementary experiments to clarify the role played by level widths, Cherenkov radiation, and radiative corrections are suggested. (J.S.R.)

34271 (LAL-1107) RAPPORT D'ACTIVITE (OCTOBRE 1963–AVRIL 1964). (Progress Report, October 1963–April 1964). (Paris. Université, Orsay. École Normale Supérieure. Laboratoire de l'Accélérateur Linéaire). June 1964. 62p.

Improvement and utilization of the accelerator are summarized, together with research progress on nucleon physics, nuclear spectroscopy, pion physics, and storage rings. Development of storage rings and associated experimental equipment and radiation control are also reported. A bibliography of the publications during this period is appended. (J.S.R.)

34272 (NASA-CR-88) HYPERSONIC MAGNETOHYDRODYNAMICS WITH OR WITHOUT A BLUNT BODY. R. H. Levy, P. J. Gierasch, and D. B. Henderson (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). July 1964. Contract NASw-748. 74p.

The hypersonic flow of a cold gas past a two-dimensional or axially symmetric body containing a two- or three-dimensional magnetic dipole with its axis oriented parallel to the flow is considered. The magnetic moment of the dipole and the size of the body are of arbitrary proportions. A uniform scalar conductivity is turned on by the shock, and the magnetic Reynolds number is low. For low values of the interaction parameter the flow is quasi-aerodynamic. Certain discrepancies existing in the literature on the flow in this regime are reconciled. At high values of the interaction parameter the nature of the flow is quite different. In this regime it consists of a thin deceleration layer (somewhat akin to the aerodynamic shock layer) and an extensive region of low-Mach-number flow (called the slow-flow region), which separates the deceleration layer from the body. The gas in the slow-flow region escapes outward at sonic velocity along the field lines. In some circumstances the entire flow field can be supported by the magnet, i.e., without the hot gas touching the body. Assuming a large compression ratio across the shock, a relatively simple analysis can be performed. Calculations covering various representative cases are exhibited; the validity and significance of these calculations are discussed. (auth)

34273 (NASA-TN-D-2400) MAGNETIC FIELD FROM A FINITE THIN CONE BY USE OF LEGENDRE POLYNOMIALS. Lawrence Flax and Edmund E. Callaghan (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Aug. 1964. 41p.

The use of zonal harmonics to evaluate magnetic fields generated by axisymmetric current sheets for all regions either near or far from the current elements is demonstrated for the case of a right-circular cone. Solutions of the equations for points within and outside the current sheet are presented. (auth)

34274 (NIRS-2(p.3-15)) PHYSICS. (Japan. National Inst. of Radiological Sciences, Tokyo).

Experiments on the average radiative capture cross sections for 30- and 65-kev neutrons, neutron capture in tin isotopes at stellar temperatures, neutron capture in samarium isotopes and the formation of the elements of the solar system, secondary electrons, background of coincidence-type beta scintillation spectrometer, determination of high energy x-ray total beam energy with a calorimeter and an ionization chamber, ^{14}C and tritium measurement using a liquid scintillator spectrometer, measurement of radioactivity in vivo by whole-body counting, elimination of ^{228}Ra from critical organs of Thorotrast patients, and particle sizing by an automatic counter and sizer are reported. (C.E.S.)

34275 (NP-14114) NUCLEAR MAGNETIC RESONANCE IN NICKEL-FLUOSILICATE BETWEEN 0.15°K AND 4.2°K. Kiyoshi Kume and Tadashi Sugawara (Tokyo Univ. Inst. for Solid State Physics). Feb. 1964. 24p.

Proton and fluorine nuclear resonance in nickel fluosilicate were studied in the paramagnetic region of temperature between 0.15°K and 4.2°K. Temperatures below one degree were obtained by the magnetic cooling of the sample itself. From the temperature dependence of the shift, the sign of the exchange interaction between Ni^{2+} ions was found to be ferromagnetic. The order of magnitude of the observed shift was well explained by the dipolar field alone. The signals disappeared when the temperature went below the Curie point. (auth)

34276 (NP-14129) ACOUSTIC ATTENUATION STUDIES OF THE FRICTIONAL FORCE ON A FAST MOVING DISLOCATION. Technical Report, Ser. A, No. 102. Taira Suzuki, Akira Ikushima, and Matto Aoki (Tokyo Univ. Inst. for Solid State Physics). Jan. 1964. 34p.

By means of measurements of the attenuation of acoustic waves in the megacycle range, resonance damping of various materials due to fast moving dislocations was studied. The damping constant B was deduced from the asymptotic behavior of the loss at higher frequencies in accordance with the theory of Granato and Lücke. Results are given for LiF, KCl, Cu, and Cu–0.13% Mn at room temperature. The temperature dependence of the damping constant was also investigated both in Cu and Cu–Mn alloy. The magnitude of the damping constant was roughly proportional to the absolute temperature in both materials. It was also recognized that the damping constants in alkali halides varied with x irradiation. For example, the damping constant for LiF at room temperature changed from the initial value 1.7×10^{-3} to 2.5×10^{-3} c.g.s. by irradiation of about 10^3 roentgen. (auth)

34277 (NP-14134) CROSSED-FIELD CHARGED PARTICLE DELAY LINES. H. G. Slottow (Illinois. Univ., Urbana. Coordinated Science Lab.). June 1964. Contract DA-28-043-AMC-00073(E). 177p. (R-214)

Crossed electric and magnetic fields are used to focus a beam of charged particles and to control the drift velocity of these particles. The novel and useful properties are: (1) the time delay can be varied continuously and rapidly; and (2) the frequency band is potentially very wide. A discussion of the effects that limit bandwidth is presented and several means for reducing the limitations are described. In particular, a hyperboloidal structure is described that can maintain equal flight times in circular delay lines; the use of plasmas is discussed, and the field averaging properties of high energy electrons are analyzed. Experiments are described in which electrons or ions drifting at speeds less than 10^4 meters/second delay signals by as much as 50 microseconds. Results, usually in the form of oscillograms, show the effects of space-charge, and in the case of tenuous plasmas, the effects of pressure on the shapes of video pulses. (auth)

34278 (NP-14174(Vol.1)) SCIENTIFIC OBSERVATIONS ON THE EXPLOSION OF A 20-TON TNT CHARGE. VOLUME 1. GENERAL INFORMATION AND MEASURE-

MENTS. Suffield Report No. 203. (Canada. Suffield Experimental Station, Ralston, Alberta). Sept. 1, 1961. 80p.

A 20-ton block-built hemisphere of TNT on the ground was detonated as a part of a program of measuring blast effects from various TNT charges. Details of the construction and detonation of the charge, the range observations, and the surface meteorological observations are given. Air blast and ground shock measurements are also given. Volume 2 gives tripartite blast measurements. (D.L.C.)

34279 (NP-14186) A KINETIC-THEORETIC DESCRIPTION OF THE FORMATION OF A SHOCK WAVE. Plasma Research Laboratory Report No. 11. C. K. Chu (Columbia Univ., New York. School of Engineering and Applied Science). June 1964. Contract AF49(638)-1254. 45p.

The classical Riemann problem — the flow of a gas in a shock tube — is treated in the context of kinetic theory as an initial-value problem for the one-dimensional Krook equation. The only simplifying assumption made is that the gas is one-dimensional: its particles all move in one direction. This corresponds to a gas with an adiabatic constant $\gamma = 3$. A finite difference method is proposed, utilizing the fact that for sufficiently small time intervals, the gas experiences essentially free molecular flow, so that the collision effects can be treated as a first order correction. The conservation laws are not used. The computed results generalize the classical solution: the computed solution agrees excellently with the classical solution, but in addition, has shock structure, diffusion of the contact discontinuity, and dispersion of the expansion wave, all incorporated. The same procedure is used to calculate steady-state shock structure, to which the shock developed in the shock tube is compared. It is seen that for the strength of the shock calculated (pressure ratio of tube 10:1, shock Mach number 1.43, $\gamma = 3$), the shock is essentially "fully developed" after about 20 mean-collision-times of the low-pressure gas. (auth)

34280 (NYO-2680-1) LATTICE AND ELECTRONIC DEFECTS IN SOLIDS. Final Report. R. Smoluchowski, C. D. Perkins, Dean J. C. Elgin, George Warfield, W. C. Johnson, and R. J. Woodrow (Princeton Univ., N. J.). June 1964. Contract AT(30-1)-2680. 34p.

Preliminary experiments on KCl and KBr were conducted using x rays in the vicinity of the K edge of the anion in order to test the Varley mechanism of multiple ionization of the anion. The results indicate that more F centers are produced with K-excitation and therefore multiple ionization is important in defect formation. A study was made on the kinetics of the annealing stages of alpha centers and interstitial ions formed in KBr by x rays below 20°K, and a model of interstitial sites is proposed. Plastic deformation up to 4% has no effect on the activation energy of ionic motion in KCl single crystals, while deformation above 10% produces a decrease of ~0.2 ev. Studies of the effects of deformation on color center formation in KCl at low temperatures indicate that the deformation changes the configuration of the defects. Annealing runs in these studies suggest that the negative ion vacancy is the diffusing species in F-center formation. Etch pit counts were made of dislocations produced by bending in KCl single crystals. Anomalous broadening of the F band in x-irradiated KCl and annealing effects were studied. Studies of electron trapping in AgCl crystals are described. Sublinear photoresponse and transient polarization currents in CdS were studied. Possible effects of a Stokes shift on the operation of three-level masers are discussed briefly. Theoretical studies on the following topics are described: phonon absorption by electron gas, donor-electron recombination in semiconductors, anomalous resistivity of Pu, ionization of excited F centers, long-wavelength tails in optical absorption, polarons, defect motion, H centers, and valences of Ce allotropes. (D.L.C.)

34281 (RM-4034-PR) POTENTIAL ENERGY CURVES FOR N_2, NO, O_2, AND CORRESPONDING IONS. F. R. Gilmore (RAND Corp., Santa Monica, Calif.). June 1964. Contract AF49(638)-700. 45p. (AD-601598)

Potential energy curves for the observed electronic states of N_2, N_2^+, NO, NO^+, O_2, and O_2^+ were calculated from published spectroscopic data by a numerical modification of the Rydberg-Klein method. Potential energy curves for a number of predicted but unobserved states of these molecules, and of the ground states of N_2^- (unstable), NO^- and O_2^-, have been estimated with the help of simple theoretical considerations, published quantum-mechanical calculations, and indirect experimental evidence. The results are presented graphically. (auth)

34282 (TID-20837) SORPTION OF GASES ON METAL SURFACES IN ULTRAHIGH VACUUM. Quarterly Progress Report No. 7, February 15 – May 15, 1964. B. Bergsnov-Hansen, A. P. Brady, N. Endow, and R. A. Pasternak (Stanford Research Inst., Menlo Park, Calif.). May 28, 1964. Contract AT(04-3)-425. 11p.

The experimental unit for the study of evaporated films is rebuilt on the basis of experience gained; the unit for the deuterium-hydrogen exchange study is tested; experience is gained with the magnetic deflection type of mass spectrometer; and properties of sorption pumps are explored. (N.W.R.)

34283 (UCRL-11390) CRYSTAL STRUCTURES AND CRITICAL TEMPERATURES OF SOME NEW SUPERCONDUCTING COMPOUNDS. Zelma Jean Johnston (California. Univ., Berkeley. Lawrence Radiation Lab.). May 5, 1964. Contract W-7405-eng-48. 35p.

An investigation of transition metal alloys having crystal structures favorable for superconductivity has resulted in the discovery of two new superconductors: Mo_3Al_2C, β-Mn structure, at 10.0°K and Mo_2BC, orthorhombic structure, at 5.4°K. Also, the previously reported transition temperature of Nb_2Al, σ-phase, and the extrapolated transition temperature of MoC, cubic B1 structure, were found to be too low; the observed values were 13.5°K and 14.2°K respectively. The role of crystal structure, generally assumed to be a secondary one in determining the superconductive properties of a material, seems open to question. The transformation of MoC from hexagonal to cubic was found to be accompanied by a 7°K change in transition temperature. Such large changes cannot be accounted for by the normal electron-to-atom ratio, but must be controlled by the lesser-known parameters such as band structure and the electron density of states at the Fermi surface. Since these parameters are definitely related to the crystal structure, the importance of the atomic arrangement must be ignored. (auth)

34284 (UCRL-13088) THE EFFECT OF EXPLOSIVE SHOCK ON THE SUSCEPTIBILITY OF MAGNETITE GROUT MIXTURE. Ashok Kumar and S. H. Ward (California. Univ., Berkeley. Inst. of Engineering Research). July 1963. Contract W-7405-eng-48. 10p. (MT-63-10)

The effects of various shock loadings on the magnetic susceptibility of magnetic grout cores were studied. The changes were found to be appreciable and to reach a maximum at a peak stress of 116 kilobars. The roles of disintegration, chemical transformation, and magnetostric-

tion in the changes are discussed. The use of magnetic grout to measure stress waves from underground nuclear explosions is discussed briefly. (D.L.C.)

34285 (WL-TDR-64-46(Vol.I)) TRG-SGD, A MONTE CARLO PROGRAM TO CALCULATE SECONDARY GAMMA RAY DOSE FROM A NUCLEAR WEAPON DETONATION. Herbert A. Steinberg (TRG, Inc., Melville, N. Y.). July 1964. Contract AF29(601)-5829. 42p.

TRG-SGD is a coding system designed to calculate the time and space distribution of secondary gamma ray dose in the atmosphere caused by neutrons leaking from a nuclear or thermonuclear device exploded in the atmosphere at ground level or higher. Volume I of this report describes the physical and analytical basis of the system. Volume II describes the code itself. (auth)

34286 (AEC-tr-6399(p.186-95)) ON THE SPECTRAL DISTRIBUTION OF THE INTERNAL PHOTOEFFECT IN CADMIUM SULFIDE SINGLE CRYSTALS EXCITED WITH X RAYS. S. V. Svechnikov and V. G. Chalaya. Translated from Radioizotopnye Metody Avtomat. Kontrolya, Akad. Nauk Kirg. SSR, Tr. Rasshiren. Soveshch. Vses. Seminara po Primeneniyu Radioaktivn. Izotopov v Izmeritel'n. Tekhn. i Priborostr., 1961, 2: 153-60(1962).

An investigation was conducted on the spectral distribution of the x-ray conductivity of CdS single crystals. The results show that the additional current increases with the hardness of the x rays. The maximum current is located in the region $\lambda \leq 0.71$ A; its exact position depends on the crystal thickness. The average lifetime of the carriers does not appear to depend on the x-ray wavelength in the 2.3 to 0.71 Å region. It is concluded that CdS single crystals can be used as selective receivers for x rays of low and medium hardness. (D.L.C.)

34287 (NP-tr-1160) INVESTIGATION ON ^{85}Kr BREMSSTRAHLUNG SOURCES. PART V. CLOSED SOURCES. H. Schaefer, G. Vormum, and W. Schmidt. Translated by A. Crozy (U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Berks, England), from Kernenergie, 6: 704-10(1963). 20p.

On the basis of measurements of methane absorption, a grade of activated charcoal was selected for absorption of krypton, and the possibility of using ^{85}Kr-charged carbon for the production of x-ray sources investigated. The spectra obtained, and also the quantum yields, are reported, particular attention being paid to gold-covered carbon as adsorbent. (auth)

34288 FAR-FLOW APPROXIMATIONS FOR PRECURSOR IONIZATION PROFILES. Lewis Wetzel (Brown Univ., Providence, R. I.). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 1208-9(July 1964).

Some features of two far-flow models which were previously introduced to account for the presence of precursor ionization ahead of a hypersonic shock front are examined. The models are based, respectively, on photoionization of the upstream gas by shock radiation and on the diffusion of charges from the actively ionized region. Neither model involves the active shock directly, their implications are useful mainly in estimating the shape of presursor ionization profiles. Profiles produced by shock radiation in gases the photon absorption cross sections of which are decreasing functions of energy above the ionization edge are emphasized. Dramatic departures from simple exponential decay are found for gases like He, atomic H, and, to a lesser extent, Ar, molecular H, and N. The average energy of the photoelectrons decays gradually until thermal equilibrium is reached for upstream. The diffusion model reduces, in the far-flow limit, to exponential decay governed by the free electron diffusion length, regardless of the nature of the space-charge fields, although these fields might produce space-charge-limited diffusion. (auth)

34289 THERMODYNAMIC PROPERTIES OF HIGH-TEMPERATURE HELIUM. J. Charles Hester and Kenneth G. Sewell (LTV Research Center, Dallas). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 1329-32(July 1964).

The thermodynamic properties of helium were calculated over a wide range of densities for temperatures up to $100 \times 10^{+3}$°K. Data are tabulated over a temperature range from 4 to 100×10^{3}°K for density ratios of 0.1, 2, 10, and 100 and for temperatures $> 50 \times 10^{3}$°K for density ratios <0.1. (D.C.W.)

34290 A SEMITOROIDAL REFLEX DISCHARGE AS A PROPULSION DEVICE. D. Pigache (Stanford Univ., Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 1332-3(July 1964).

The performance of a semitoroidal reflex discharge with cylindrical emitting cathodes in both open ends and with a magnetic field provided by coils around the tube is discussed in terms of observations on toroidal reflex discharges and theoretical observations. (D.C.W.)

34291 NONSYMMETRICAL PROPERTY OF MAGNETIC MONOPOLES. N. Strax. Am. J. Phys., 32: 615-17(Aug. 1964).

It is shown that the two opposite signs of magnetic monopoles can be given an absolute, rather than relative, significance. (D.C.W.)

34292 ROTATION SPECTRA OF THE $^{32}S^{16}O^{16}O$ MOLECULE. R. Van Riet (Centre de Physique Nucleaire et Moleculaire, Heverle-Louvain, Belg.). Ann. Soc. Sci. Bruxelles, Ser. I, 78: 113-20(June 15, 1964). (In French)

The rotational spectrum of SO_2 enriched to 2% in ^{32}S was measured. For the ground state (0,0,0), the lines observed were identified; and rotational constants and distortion coefficients were calculated in the first-order approximation, solving the systems of equations by the least squares method. For the first excited state (0,1,0), two transitions were identified, and some rotation constants were proposed. (tr-auth)

34293 NOTE ON THE INVARIANCE OF THE ACTION INTEGRAL. Kristian Barstad Dysthe (Univ. of Bergen). Arbok Univ. Bergen, Mat.-Nat. Ser., No. 14, 1-6(1963).

The longitudinal invariant $F = \oint p_{||}\, ds$ for a charged particle trapped in a magnetic field is studied. A rough estimate of the drift across the field lines is first obtained to test the limit of validity of the assumption that the particles are tied to the field lines. An expression for dF/dt is then derived and shown to be zero for the special case of an axially symmetric field. (auth)

34294 ON THE INDEPENDENCE OF THE VELOCITY OF LIGHT OF THE MOTION OF THE LIGHT SOURCE. T. Alvaeger, A. Nilsson, and J. Kjellman (Univ. of Stockholm; Nobel Inst. of Physics, Stockholm; and Research Inst. of National Defence, Stockholm). Arkiv Fysik, 26: 209-21(1964).

The empirical evidence in favor of the second postulate of special relativity, i.e. that the velocity of light is independent of the motion of its source, is mainly of astronomical origin. Until recently no conclusive terrestrial tests of the postulate have been reported. A one way terrestrial experiment where the principle was to measure the velocity difference of gamma radiation emitted from a moving source (C^{12*}, velocity $v = 1.8 \cdot 10^{-2}$ c) and a source

at rest (O^{16*}) was performed. The velocity difference can be written k·v. Emission theories give k = 1, while the second postulate implies k = 0. The experiment gives k = 0.1 ± 0.1. (auth)

34295 SOME EXACT SOLUTIONS OF THE EQUATIONS OF MAGNETOHYDRODYNAMICS FOR MAGNETIC PLANE-SYMMETRICAL FIELDS. E. Infeld (Inst. for Nuclear Research, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys., 12: 233-8(1964).

Solutions of the MHD equations are outlined and examined for the case of magnetic fields having plane symmetry and satisfying curl $H_0 = 0$, where H_0 denotes the external, undisturbed field. Both quadrupole fields and fields with hyperbolic lines are considered. Solutions of a boundary value problem and an initial value problem for general time dependence are investigated. (D.C.W.)

34296 PRELIMINARY RESULTS OF INVESTIGATIONS ON MAGNETO-GAS-DYNAMIC PHENOMENA IN THE CASE OF PULSATING COMBUSTION. J. Smigielski and J. Kielbinski (Inst. of Fluid Flow Machines, Polish Academy of Sciences, Danzig). Bull. Acad. Polon. Sci., Ser. Sci. Tech., 12: 11-18(1964).

The electric conductivity of combustion gases in a pulsating (resonance) combustion chamber (gasoline fuel) was measured, together with the electromotive force induced between the electrodes of the test section in a magnetic field. The pressure pulsation in the combustion space was also measured. (D.C.W.)

34297 HIGH-ENERGY IONS FROM A Q-SWITCHED LASER. N. R. Isenor (Univ. of Waterloo, Ont.). Can. J. Phys., 42: 1413-16(July 1964).

The laser power density falling on Zn, Mg, and Pb was varied by moving the focusing lens, and the transit times of the ions were measured. The results indicate that the energy of the ions expelled is directly proportional to the power density and is independent of the target element. (D.C.W.)

34298 MÖSSBAUER EFFECT. Jarmila Dlouha (Charles Univ., Prague). Cesk. Casopis Fys., 14: 222-46 (1964). (In Czech)

Resonant absorption and emission of gamma radiation accompanied by free recoil is described, and the Mössbauer effect is explained. The calculation of the probability of recoilless gamma absorption and the shift of the Mössbauer line in regular crystals is outlined. Isotopes and equipment suitable are summarized, and its most important uses are surveyed. (auth)

34299 DETERMINATION OF THE RELAXATION TIME OF THE ELECTRON TEMPERATURE IN THE POSITIVE COLUMN OF AN ELECTRIC DISCHARGE. M. Šicha (Charles Univ., Prague), V. Seselý, J. Novák, and L. Pekárek. Czech. J. Phys., 14: 247-55(196) (In German)

A method of measuring the relaxation time of the temperature of electrons in the positive column of an electric discharge is described. The method uses measurements of the phase shift between the course of the electron temperature and that of the concentration of electrons in artificially excited moving striations of small amplitude. These data and the values measured for the electric field and temperature of the electrons in a homogeneous column are used to calculate the relaxation time of the electron temperature on the assumption that the diffusion of the electron temperature has no substantial influence on the time. (auth)

34300 VIRIAL COEFFICIENTS AND THE CLASSICAL THEORY OF FLUIDS FOR THE SQUARE-WELL POTENTIAL. Donald A. McQuarrie (Michigan State Univ., East Lansing). J. Chem. Phys., 40: 3455-71(June 15, 1964).

The term $g_2(r)$ proportional to the square of the density in the expansion of the radial distribution function in powers of the density was evaluated for a square-well potential for the Born–Green–Yvon integral equation, the Kirkwood integral equation, the Percus–Yevick integral equation, the hyperchain approximation, and an integral equation derived by Meeron. The square-well potential used has a hard-core diameter of σ and attractive diameter of 2σ. Each $g_2(r)$ is then used to calculate D_P, the fourth virial coefficient calculated from the pressure equation, and D_c, that calculated from the compressibility equation, for the above five liquid theories. This allows a comparison over the entire temperature range, rather than at infinite temperature, the only value given by the previously used hard sphere potential. It is shown that the Percus–Yevick equation yields virial coefficients in best agreement with the exact value over a large temperature range. All the results presented are low-order polynomials in $f = \exp(\epsilon/kT - 1)$, where ϵ is the depth of the well, and reduce to the hard-sphere results when f goes to zero. (auth)

34301 STARK EFFECTS ON THE NUCLEAR QUADRUPOLE COUPLING OF ^{35}Cl IN SODIUM CHLORATE. F. A. Collins and N. Bloembergen (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 40: 3479-92(June 15, 1964).

Changes in the electric-field-gradient tensor q induced by an applied electric field E and stress δ are described by the relation $e(\Delta q)_{ij} = R_{kij}{}^{\sigma} E_k + T_{ijlm}{}^{\sigma}{}_{lm}$. The magnitudes and absolute signs of the five independent components of R^{σ} for ^{35}Cl in $NaClO_3$ were measured at 77°K and related to the absolute atomic configuration of the crystal. The numerical values are in units of 10^9 cm^{-1}, $R_{111}{}^{\sigma} = -0.42$, $R_{222}{}^{\sigma} = 2.43$, $R_{333}{}^{\sigma} = -2.22$, $R_{113}{}^{\sigma} = -1.53$, and $R_{123}{}^{\sigma} = +3.53$, with respect to the following coordinate system at a Cl site. The positive x_3 axis points from Na^+ to ClO_3^-, i.e., towards the [111] direction that develops a positive piezoelectric charge for a tension σ_{32}. The positive x_1 axis passes through an oxygen site and x_2 completes the right-handed set in the plane of the oxygen triangle. The electric field effects at constant stress and at constant strain are nearly equal. They are attributed to variations in the electron orbitals of the chlorate group and to changes in the ionic lattice sums outside this group. (auth)

34302 LOW-FREQUENCY VIBRATIONS OF CRYSTALLINE BIPHENYL. Karlheinz Krebs (Euratom, Ispra, Italy), Santino Sandroni, and Giuseppe Zerbi. J. Chem. Phys., 40: 3502-6(June 15, 1964).

The spectrum of inelastically scattered slow neutrons was obtained for polycrystalline biphenyl. Whereas translational modes account for the broad general features of the whole spectrum, the fine structure observed can be interpreted in terms of librational and q-independent internal modes. The six theoretically predicted librations were assigned. Moreover, there are good reasons to believe that the torsional internal mode, practically inactive in infrared and Raman, occurs in the INS spectrum at about 70 cm^{-1}. (auth)

34303 THEORY OF SUBEXCITATION ELECTRON SCATTERING BY MOLECULES. I. FORMALISM AND THE COMPOUND NEGATIVE-ION STATES. Joseph C. Y. Chen (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 40: 3507-13(June 15, 1964).

The problem of slow-electron scattering by molecules is treated formally with explicit consideration of the possible effects of the compound negative-ion states. The formulation is based on the treatments for nuclear reactions and scattering, in particular the unified treatment recently advanced by Feshbach. The transition matrix for both direct and resonance scattering, describing the excitation of the nuclear motion of the target molecule, was obtained. The influence of the compound negative-ion states on the equivalent scattering potential for resonance scattering was investigated in some detail. (auth)

34304 THEORY OF SUBEXCITATION ELECTRON SCATTERING BY MOLECULES. II. EXCITATION AND DE-EXCITATION OF MOLECULAR VIBRATION. Joseph C. Y. Chen (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 40: 3513-20(June 15, 1964).

The proposed mechanism for the excitation and de-excitation of molecular vibration by slow electron impact involving compound negative-ion states as intermediates was studied in some detail in light of the theory presented in I of this series. The absolute orders of magnitude of the cross sections for such collisional processes are calculated for the (N_2,e) system, where detailed measurements were recently made for the excitation of the ground N_2 molecules to various excited vibrational states. The observed multipeak structures for the excitation functions are accounted for. The energy dependence of the cross sections for the excitation and de-excitation of a vibrationally excited N_2 molecule exhibits similar multipeak structures in the same energy region. An interpretation of such multipeak structures is offered. (auth)

34305 SPECTRUM OF Er^{3+} IN SINGLE CRYSTALS OF Y_2O_3. P. Kisliuk (Aerospace Corp., Los Angeles), W. F. Krupke, and J. B. Gruber. J. Chem. Phys., 40: 3606-10 (June 15, 1964).

The spectrum of Er^{3+} in single crystals of Y_2O_3 was examined from 0.225 to 2.4 μ in absorption and fluorescence, and energy levels were assigned. The Slater integrals and spin-orbit coupling parameter were determined, which give the best over-all agreement between the centers of gravity of the observed groups of levels and the $4f^{11}$ SLJ energy levels of the free Er^{3+} ion; they are $F_2 = 429.583\ cm^{-1}$, $F_4 = 65.012\ cm^{-1}$, $F_6 = 7.136\ cm^{-1}$, $\zeta = -2383.17\ cm^{-1}$. Of the two inequivalent cation sites, C_2 and C_{3i}, it can be demonstrated with consistency that the site without inversion symmetry (C_2) gives rise to the entire observed spectrum. (auth)

34306 OPTICAL ABSORPTION OF THE F AND K BANDS IN RUBIDIUM CHLORIDE. G. E. Stungis, J. J. Markham, and G. A. Noble (Illinois Inst. of Tech., Chicago). J. Chem. Phys., 40: 3634-40(June 15, 1964).

Detailed measurements on the optical absorption of the F center in rubidium chloride are reported. The F centers were produced by additive coloration and ionizing radiation. The photon energies for the point of maximum and points of half-maximum absorption are determined for temperatures between 4 and 373°K. A single effective phonon frequency of $\omega = (2\pi) \times 2.43 \times 10^{12}\ sec^{-1}$ was obtained from the dependence of the half-width on temperature. The shape of the F band is independent of temperature and is not symmetrical. The moments are computed. The asymmetry is greater than that predicted by the Poisson distribution and the second moment is close to that of a Gaussian. The ratio of the maximum of the K band to that of the F band is 0.03 in vacuum distilled material. In unpurified material this value is not reproducible and may be three times as large. (auth)

34307 RELATION BETWEEN SELF-DIFFUSION COEFFICIENTS AND QUANTUM EQUILIBRIUM PROPERTIES. H. Friedmann and W. A. Steele (Universite Libre, Brussels). J. Chem. Phys., 40: 3669-70(June 15, 1964).

A number of approximate theoretical equations that give the molecular friction constant in terms of the average Laplacian of the intermolecular potential were compared with the experimental data of Naghizadeh and Rice. Values for the average Laplacian were obtained from experimental data on the changes in thermodynamic properties with isotopic substitution in nearly classical fluids. The experimental average Laplacians differ considerably from the values obtained previously by computation from the molecular properties. Although none of the approximate equations is capable of exactly reproducing the experimental data, it was concluded that one of them gives reasonably accurate values for the friction constants and self-diffusion constants of simple dense fluids. (auth)

34308 ON THE CALCULATION OF THE MOLECULAR FRICTION CONSTANT. Peter Gray and Stuart A. Rice (Univ. of Chicago). J. Chem. Phys., 40: 3671-2(June 15, 1964).

The use of isotope-separation data to obtain experimental values for the mean-square force acting on a molecule in a liquid and the implications of this data for the theory of self-diffusion are discussed. (auth)

34309 ANALYSIS OF HIGH-RESOLUTION NMR SPECTRA BY MEANS OF THE NUCLEAR OVERHAUSER EFFECT AND BY TRANSITORY SELECTIVE IRRADIATION (TSI) METHODS. Ragnar A. Hoffman (Uppsala Univ.), Bo Gestblom, and Sture Forsén. J. Chem. Phys., 40: 3734-5 (June 15, 1964).

Characteristic features of various methods that have been devised in which radioinduced intensity changes are used to establish the energy level arrangements in high-resolution NMR spectra are discussed. Distinction is made between the nuclear Overhauser effect and Transitory Selective Irradiation (TSI) methods, and the use of both are described. (P.C.H.)

34310 SPATIAL DISTRIBUTION OF INTENSITY IN A HELIUM AFTERGLOW. Franklin E. Niles and W. W. Robertson (Univ. of Texas, Austin). J. Chem. Phys., 41: 1523-4(Sept. 1, 1964).

A graphical presentation is given of the change with time in the spatial distribution of intensity of radiation and thus of ion concentration in a cylindrical discharge cell with a rather extreme asymmetry in the initial charge distribution. Time-sampling techniques were used to measure the emission of the He afterglow for a pressure of 4.90 torr and a discharge current of 4 mA from a cylindrical Pyrex glass cell of length 17 cm and radius 2.35 cm. The intensity distribution for 300 μsec (only 100 μsec into the afterglow) indicates a trend toward the fundamental diffusion mode. The intensity distribution for 5 msec (molecular radiation only at this time) coincides closely with the shape of the $J_0^2(r)$ curve, thus indicating that the fundamental diffusion mode has become the principal diffusion mode. It is shown definitely that the emission is the result of a volume process during the afterglow period. (P.C.H.)

34311 ON TRAPPED TRAJECTORIES IN BROWNIAN MOTION. Julius L. Jackson (Universiteit, Leiden) and Sam R. Coriell. J. Math. Phys. (N. Y.), 5: 1075-8(Aug. 1964).

The Brownian motion of an ion in the attractive field of an infinite line charge is investigated with reference to the existence of trapped trajectories, trajectories which

never depart from the neighborhood of the center of attraction. It is shown that there is a discontinuity in the nature of the Brownian motion as a function of the line charge density, marked by the appearance of trapped trajectories when the line charge density becomes greater than a critical value. (auth)

34312 ON THE NUMBER OF SELF-AVOIDING WALKS. [PART] II. Harry Kesten (Cornell Univ., Ithaca, N. Y.). J. Math. Phys. (N. Y.), 5: 1128-37(Aug. 1964).

Let $\chi_n(d)$ [resp. $\gamma_{2n-1}(d)$] be the number of self-avoiding walks (polygons) of n $(2n-1)$ steps on the integral points in d dimensions. It is known that $\beta_d = \lim_{n\to\infty}[\chi_n(d)]^{1/n} = \lim_{n\to\infty}[\gamma_{2n-1}(d)]^{\frac{1}{2n-1}}$. β_d is compared with $\beta_{d,2r} = \lim_{n\to\infty}[\chi_{n,2r}(d)]^{1/n}$, where $\chi_{n,2r}(d)$ is the number of n-step walks on the integral points in d dimensions with no loops of 2r steps or less. The walks counted in $\chi_{n,2r}(d)$ may visit the same point more than once as long as there are more than 2r steps between consecutive visits. It turns out that $\beta_{d,2r} - \beta_d = O(d^{-r})(d\to\infty)$, and it follows in particular that $\beta_d = 2d - 1 - \frac{1}{2}d + O(1/d^2)(d\to\infty)$. It is also shown that, for suitable constants $\alpha_6 = \alpha_6(d)$ and $\alpha_7 = \alpha_7(d)$, $\chi_n(d) \leq \beta_n \exp[\alpha_6 n^{2/(d+2)} \log n]$ and $\beta^{2n-1} \exp[-\alpha_7 n^{2/(d+1)} \log n] \leq \gamma_{2n-1}(d)$. (auth)

34313 PRODUCT PROPERTY AND CLUSTER PROPERTY EQUIVALENCE. S. Sherman (Wayne State Univ., Detroit). J. Math. Phys. (N. Y.), 5: 1137-9(Aug. 1964).

Uhlenbeck and Ford in their presentation of the Ursell development express a sequence of symmetric functions W_N in terms of another sequence of symmetric functions U_N. They invert this sequence of equations and remark that from the first set of equations it follows that the product property of W_N sequence is equivalent to the cluster property for the U_N sequence. They ask for a simple proof of the equivalence. A modification of an algebra developed by Bohnenblust to prove Spitzer's formula on the fluctuations of the sums of independent, identically distributed, random variables is used systematically to invert the relations and to prove the equivalence under lighter assumptions than were previously used. (auth)

34314 STUDY OF THE TRAJECTORIES OF SUBMICRONIC PARTICLES IN IONIZED FIELDS. Jack Joubert, Claude Henry, and Charles Eyraud (Institut National des Sciences Appliquees, Lyon and Faculte des Sciences, Lyon). J. Phys. (Paris), 25: Suppl. to No. 3, 67A-72A(Mar. 1964). (In French)

Relations for charge acquisition and trajectories of solid particles (100–5000 Å) in an ionized field are derived and compared with experimental results on the charge number, radial velocity, and sedimentation distance as a function of particle size. (D.C.W.)

34315 A NOTE ON THE DERIVATION OF THE GENERALIZED BOLTZMANN EQUATION. Syu Ono (Tokyo Univ.). J. Phys. Soc.,Japan, 19: 815-18(June 1964).

On the basis of a cluster expansion of the classical Liouville operator the Boltzmann equation is generalized to higher densities. This expansion is analogous to the Mayer expansion known in equilibrium statistical mechanics, and furnishes a simple prescription to write down the terms of the higher order in the number density for the spatially homogeneous as well as the spatially inhomogeneous case. As the boundary conditions for the distribution functions the weakening of the correlation of the initial distribution is employed. (auth)

34316 ON THE KUTTA-JOUKOWSKI CONDITION IN MAGNETOHYDRODYNAMICS. Ken-ichi Kusukawa (Tokyo Metropolitan Univ.). J. Phys. Soc. Japan, 19: 1031-41(June 1964).

The flow of an incompressible viscous fluid with electric conductivity past an insulated flat plate at a small incidence, in the presence of an aligned magnetic field, is studied. The solution for finite hydrodynamic and magnetic Reynolds numbers R, R_m is uniquely determined by the linearized theory. Taking the limiting process: $R = \infty$ and $R_m = \infty$, but $\epsilon = R_m/R$ = finite, the flow of an inviscid fluid with infinite electric conductivity with a proper circulation is obtained. In the superalfvenic case the circulation coincides with that expected by the conventional Kutta-Joukowski condition, while in the subalfvenic case the circulation is given as a function of ϵ and the Alfven number. (auth)

34317 THE HYDROMAGNETIC STABILITY OF THE MODIFIED PLANE COUETTE FLOW IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Tsunehiko Kakutani (Kyoto Univ.). J. Phys. Soc. Japan, 19: 1041-57 (June 1964).

The hydromagnetic stability against small disturbances is investigated on the plane laminar motion of an electrically conducting fluid between parallel plates in relative motion in the presence of a transverse magnetic field. Curves of the neutral stability in the (α,R)-plane (α, the wave-number; R, the Reynolds number) are calculated for various values of the Hartmann number M. It is thus found that the critical Reynolds number R_c is infinite for $M < 3.91$ as well as for ordinary plane Couette flow. As M increases from 3.91, R_c decreases rapidly to a minimum value of 3.8×10^4 when $M = 5.4$ and then increases steadily to its asymptotic value, 50000M, for sufficiently large values of M(>15). Thus, we may conclude that the flow is always stable for $0 \leqq M \leqq 3.91$, destabilized by the magnetic field for $3.91 < M < 5.4$ and stabilized reversely for $M > 5.4$. (auth)

34318 SELF-SIMILAR AND PSEUDOSIMILAR SOLUTIONS OF STRONG BLAST WAVES IN ELECTROGASDYNAMICS. Koichi Ohima (Tokyo Univ.). J. Phys. Soc. Japan, 19: 1057-63(June 1964).

By adding the Poisson equation to the set of equations used in conventional blast wave analysis, the effects of the presence of charged particles in a gas are examined. This analysis is specially applicable to a strong blast wave of electron gas propagating through an electrically neutral plasma. Two similarity parameters result, one of which corresponds to the usual parameter, and the other contains the effect of the electric charge. Due to the low mass of the electrons as compared with that of the ions, a charge separation takes place at the shock front, resulting in a body force which tends to weaken the shock strength. Contrary to the classical gasdynamics, self-similar solutions of the electrogasdynamic blast wave with a constant energy can no longer be found. However, a pseudosimilar solution is possible which yields a constant energy. (auth)

34319 A SIMILAR STAGNATION-POINT MAGNETOHYDRODYNAMIC FLOW. A. B. Cinober and A. G. Stern (Inst. of Physics, Academy of Sciences, Latvian SSR). Latvijas PSR Zinatnu Akad. Vestis, No. 1, 15-19(1964). (In Russian)

A new similar stagnation-point flow of electrically conducting inviscid fluid in the presence of a strong uniform magnetic field is obtained. The magnetic field is normal to the undisturbed uniform flow. Induced magnetic field is neglected, i.e., $Re_m \ll 1$. (auth)

34320 PROPAGATION OF ELECTROMAGNETIC FIELD IMPULSE IN MOVING CONDUCTING MEDIUM. G. Ya. Sermon (Inst. of Physics, Academy of Sciences, Latvian SSR). Latvijas PSR Zinatnu Akad. Vestis, No. 1, 33-44(1964). (In Russian)

The problem of propagation of electromagnetic field im-

pulse in a conducting medium is considered. Precise formulas are obtained in the case in which the field is produced by two parallel infinite wires with opposite directions of current, and in the case of a circular circuit in which the field is produced by a circular wire of equal radius. Graphs are produced showing results of numerical evaluations of the formulas obtained. (auth)

34321 TWO-DIMENSIONAL FLOW IN MAGNETOGASDYNAMICS. V. E. Kozirenko (Riga Red Banner School of Military Engineering, Latvian SSR). Latvijas PSR Zinatnu Akad. Vestis, No. 2, 35-9(1964). (In Russian)

The application of inverse methods of the classic gas dynamics to magnetogasdynamics is discussed. The orthogonality of the gas speed and the electric current vectors in magnetic field as a result of a homogeneous translation flow or a radial motion from the source is described. (auth)

34322 ON ELECTRON DRIFT VELOCITIES IN MIXTURES OF NOBLE GASES AND "MODERATOR" GASES. W. K. Brown and T. H. Jensen (Danish Atomic Energy Commission, Risö). Nucl. Instr. Methods, 27: 259-65 (May 1964).

A theoretical investigation of electron drift velocities in noble gas-moderator gas mixtures under the influence of an electric field yielded a new scaling law. The conditions limiting the validity of the scaling law are discussed. Comparison of the law to existing experimental data (Ne, Ar, Kr, Xe with CO_2; ArKr with CH_4) demonstrates the validity over a wide range. The functions G and H derived from these data are presented. The existing drift velocity data, having been condensed to this more manageable form, are used to calculate electron transit times in cylindrical proportional counters using any of these gas mixtures. (auth)

34323 IRREVERSIBLE VAPOR CONDENSATION. Victor H. Heiskala (Iowa State Univ., Ames). Nucl. Sci. Eng., 19: 418-22(Aug. 1964).

Irreversible condensation in the general vapor was studied theoretically. Assuming a mechanism of the step-wise addition of molecules to clusters in the vapor by collisions under nonequilibrium, steady-state conditions, a general rate expression for homogeneous condensation was derived. The expression was then elucidated for two vapor types, of which sodium vapor and water vapor are examples. The theory is in good agreement with qualified experimental data for water vapor over a wide range of temperatures. (auth)

34324 REFLECTION OF STRONG BLAST WAVES. Tien Sun Chang (Virginia Polytechnic Inst., Blacksburg) and Otto Laporte. Phys. Fluids, 7: 1225-32(Aug. 1964).

The reflection of strong point-source blast waves is studied using the continuum concept of flow of ideal gases. Methods of obtaining the upper and lower bounds as well as a Taylor series expansion of the position of the reflected shock is considered. The procedure of studying the flow variables near the reflected shock is also described. (auth)

34325 SHOCK STRUCTURE IN A SIMPLE DISCRETE VELOCITY GAS. James E. Broadwell (Thompson-Ramo-Wooldridge Space Tech. Lab., Redondo Beach, Calif.). Phys. Fluids, 7: 1243-7(Aug. 1964).

The structure of a shock wave in a simple discrete velocity gas—a gas in which the molecules move with a finite set of velocities—is discussed. The Boltzmann equation becomes, for this gas, a set of coupled differential equations which can be solved exactly. The solution describes an infinite Mach number shock in a gas consisting of hard elastic spheres. Although only six molecular velocities are considered, and the solution is easy to obtain, it compares remarkably well with those of other investigators. (auth)

34326 SOME NEW VARIATIONAL PROPERTIES OF HYDROMAGNETIC EQUILIBRIA. Harold Grad (New York Univ., New York). Phys. Fluids, 7: 1283-92(Aug. 1964).

Earlier variational formulations of problems in hydromagnetic equilibrium are extended by partially relaxing some of the boundary conditions. The resulting natural boundary conditions reflect situations of physical interest. Part of the analysis is done in the large and yields a simple intuitive condition which must be satisfied by an equilibrium which is free to move at its ends (the magnetic lines are not tied). Applications are made to stability theory. (auth)

34327 PRODUCTION AND DISSIPATION OF MAGNETIC ENERGY BY DIFFERENTIAL FLUID MOTIONS. Alfred Clark, Jr. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 7: 1299-1305(Aug. 1964).

An exact solution is given for the time-development of a magnetic field in a two-dimensional stagnation flow, with the field lines being in the plane of the flow and parallel to the stagnation plane. The solution is given for an arbitrary initial field, and several examples are discussed in detail. The flow tends to increase magnetic energy by stretching the field lines and also tends to accentuate spatial inhomogeneities of the field by compressing the length scale in a direction perpendicular to the stagnation plane. The results show that the combination of these two effects can lead to exceptionally high rates of dissipation of magnetic energy by Joule heating. (auth)

34328 OSCILLATING BOUNDARY LAYER IN MAGNETOHYDRODYNAMICS. II. CONDUCTING BOUNDARY. Douglas R. Caldwell (Univ. of Chicago). Phys. Fluids, 7: 1338-48(Aug. 1964).

The generation of Alfvén waves by an oscillating, electrically conducting boundary was studied theoretically. Evidence concerning the validity of the calculations was obtained by measurements of the damping and period of a torsional pendulum suspended in mercury in the presence of an axial magnetic field. The electrical potential associated with the Alfvén waves was also measured. (auth)

34329 MAGNETOFLUIDMECHANIC BLAST WAVES IN A MEDIUM WITH FINITE ELECTRICAL CONDUCTIVITY. Paul S. Lykoudis (Rand Corp., Santa Monica, Calif. and Purdue Univ., Lafayette, Ind.). Phys. Fluids, 7: 1372-80 (Aug. 1964).

The classical theory of blast waves is extended in the case of an electrically conducting medium in the presence of a magnetic field. The plane (j = 0), cylindrical (j = 1), and spherical (j = 2) cases are discussed for a fluid possessing electric conductivity varying with an appropriate power of temperature (say T^{σ_1}), whereas the mass-density distribution of the medium in the undisturbed region and the imposed magnetic field are allowed to be inverse powers of the spatial coordinate r (say $r^{-\omega}$ and r^{-b}, respectively). For small magnetic Reynolds numbers it is found that similarity solutions exist provided the following relation is satisfied: $4b + 2\sigma_1(1 + j - \omega) = 3 + j + \omega$. The case of cylindrical symmetry with constant mass density and magnetic field parallel to the cylindrical wave is discussed in detail ($\omega = b = 0$, $\sigma_1 = j = 1$). Numerical results are provided for different values of the specific heat ratio. It is found that the magnetic field decelerates the fluid be-

hind the shock wave, producing at the same time higher temperatures. (auth)

34330 CALCULATIONS OF SHOCK TUBES WITH CURRENT CROWBARRING. J. A. Bakken (Univ. of Bergen). Phys. Fluids, 7: 1381-3(Aug. 1964).

Current crowbarring in electromagnetic shock tubes is analyzed in terms of the snowplough model. The analysis has a bearing upon the crowbar action of secondary discharges which may give rise to decoupled current loops. Expressions relating current sheet position to time, sheet speed, and current are given in nondimensional form. It is shown that the speed may continue to increase after crowbarring. (auth)

34331 EIGENFUNCTIONS OF THE BOLTZMANN COLLISION OPERATOR. J. D. Louck and G. P. DeVault (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 7: 1388-90(Aug. 1964). (LADC-6167)

A derivation is presented in which it is shown that the collision integral operator of the Boltzmann equation for Maxwell molecules can be cast into a form containing an exponential operator. The operator in the exponent is the three-dimensional harmonic oscillator hamiltonian. From this form of the collision operator it is shown that the oscillator wave functions are also eigenfunctions of the collision operator. (C.E.S.)

34332 INFLUENCE OF THE END PLATE ON SHOCK REFLECTION IN THE HIGH-EXPLOSIVE SHOCK TUBE. R. A. Jeffries (Los Alamos Scientific Lab., N. Mex.), L. B. Seely, and R. G. Fowler. Phys. Fluids, 7: 1390-1(Aug. 1964). (LADC-6237)

Temperatures of 2 ev with 10^{18} ions cm^{-3} were produced in helium by reflecting shocks against a high-explosive shock tube end plate. The reflected shock was studied and was found to vary from predictions of one-dimensional shock theory. A comparison of a reflection against a Pyrex end plate with one against a shock of equal strength is reported. It is concluded that the end plate does not appreciably perturb hydrodynamics or kinetics of reflection in a helium-filled high-explosive shock tube. (C.E.S.)

34333 MAGNETIC FIELD DIFFUSION ASSOCIATED WITH AN IONIZING SHOCK WAVE INTERACTING WITH AN ELECTROMAGNETIC FIELD. Jan Rosciszewski and Arnold Kritz (General Dynamics/Astronautics, San Diego, Calif.). Phys. Fluids, 7: 1393-4(Aug. 1964).

The interaction of an ionizing shock wave with an electromagnetic field is discussed, and the diffusion of the magnetic field is calculated assuming linearized flow behind the shock wave of arbitrary strength. (C.E.S.)

34334 SUPPRESSION OF NUCLEAR DYNAMIC POLARIZATION BY RADIO FREQUENCY RADIATION. G. E. G. Hardeman and G. Gerritsen (N. V. Philips Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 11: 20-1(July 1, 1964).

The large frequency shifts of the nuclear spins surrounding a paramagnetic impurity center in a semiconductor relative to the normal Larmor frequency in the external magnetic field are shown to have a great influence on the mechanism of the enhancement of the polarization of the remote nuclear spins in the lattice by means of microwave radiation. It is also shown that the enhancement can be decreased by the presence of a perturbing radiation, which selectively destroys the polarization of groups of nuclear spins interacting with the paramagnetic centers. Phosphorus-doped silicon was studied. (R.E.U.)

34335 HAS THE GEODESIC POSTULATE ANY SIGNIFICANCE FOR A FINITE MASS? M. Carmeli (Israel Inst. of Tech., Haifa). Phys. Letters, 11: 24-5(July 1, 1964).

The validity of the geodesic equation of motion of a test particle moving in a gravitational field is shown to hold up to the 6th order (EIH Equations), but to lose significance for higher approximations. (R.E.U.)

34336 INTEGRAL EQUATION FOR CLASSICAL FLUIDS AND THE LATTICE GAS. D. Levesque and L. Verlet (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Letters, 11: 36-7 (July 1, 1964).

The hypermelted chain and Persus Yevick integral equations for two-body correlation functions of classical fluids are applied to the lattice gas with nearest-neighbor interactions. (R.E.U.)

34337 DEGENERATE BOSE SYSTEM. I. QUANTUM STATISTICAL THEORY. Franz Mohling (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 135: A831-54(Aug. 17, 1964).

The theory of a degenerate system of interacting bosons is developed using the x-ensemble formulation of quantum statistics, previously introduced by Lee and Yang. Particular attention is devoted to the self-energy structure of the graphs of the theory, and it is shown that the complete analysis of this structure involves an intimate mixing of the effects of particle statistics and particle interactions. Therefore, the effect of statistics, which causes Bose-Einstein condensation, becomes mixed with the dynamics in a real system. A prescription is given for the grand potential in which all self-energy effects are included in the line factors of master graphs. An expression for the pair-distribution function of a degenerate Bose system is also derived. (auth)

34338 DEGENERATE BOSE SYSTEM. II. A TRANSFORMATION OF QUANTUM STATISTICAL THEORY. Franz Mohling (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 135: A855-75(Aug. 17, 1954).

In the first paper of this series, the master-graph formulation of the Lee-Yang quantum statistical theory for a degenerate Bose system was derived. In the present paper, this entire theory is transformed from a free-particle description to a quasiparticle description by means of a Λ transformation. This transformation leaves the master-graph formulation of the theory essentially unchanged, while at the same time introducing the quasiparticle energy-momentum relation and the quasiparticle interaction function into the theory. The transformation is motivated by a study of the very low-temperature behavior of the fundamental integral equation of the theory. An interesting feature of the transformed theory is that it contains two quasiparticle energy-momentum relations, $\epsilon_+(k)$ and $\epsilon_-(k)$. The understanding of this result is not achieved in this paper, although the possibility of a double quasiparticle spectrum has previously been suggested by Lieb. (auth)

34339 DEGENERATE BOSE SYSTEM. III. DILUTE GAS OF HARD SPHERES. Franz Mohling (Univ. of Delhi). Phys. Rev., 135: A876-90(Aug. 17, 1964).

The general formalism developed in the preceding two papers of this series is applied to the dilute gas of Bose hard spheres. The well-known results of Lee, Huang, and Yang for the ground state of this model gas are duplicated. The possibility of including a weak attraction in addition to the repulsive cores is considered, and it is shown that the simple scattering length approximation is valid for positive scattering lengths. (auth)

34340 SILICON-CRYSTAL DETERMINATION OF THE ABSOLUTE SCALE OF X-RAY WAVELENGTHS. Ivars Henins and J. A. Bearden (Johns Hopkins Univ., Baltimore). Phys. Rev., 135: A890-8(Aug. 17, 1964).

In a recent evaluation of the atomic constants, the value of Avogadro's number is $N = 6.02252 \times 10^{23}$ (g mole)$^{-1}$ ± 11 ppm (probable error). Measurements on the atomic weight of silicon give A = 28.0857 ± 10 ppm. Precision measurements of the density of silicon combined with the above values in the Bragg equation $a = (fA/\rho N)^{1/3}$ result in an absolute grating constant of high precision. X-ray-diffraction measurements with the same crystal yield the grating constant in x units; thus the conversion factor from x units to cm can be evaluated. X-ray and density measurements have been made on 17 selected silicon crystals from four different sources. The statistical error in the measurement of the densities of the 17 crystals was ±0.4 ppm. To obtain the absolute density error, a 3 ppm probable error in the density of water must be added, giving a total error of ±3.1 ppm. The measured densities of two of the 17 crystals differed from the average by more than 3 σ, probably indicating a difference in the density of the crystals. The x-ray-diffraction measurements were made with a double-crystal spectrometer using the copper $K\alpha_1$ and $K\alpha_2$ lines. The wavelengths in angstroms were evaluated from the Bragg law for each of the 17 crystals and for the α_1 and α_2 lines. The average wavelengths were Cu $K\alpha_1$ = 1.540 563 Å ± 5 ppm, and Cu $K\alpha_2$ = 1.544 390 Å ± 5 ppm. Taking the peak wavelength values of 1537.400 xu ± 1 ppm for the Cu $K\alpha_1$ and 1541.219 xu ± 6.5 ppm for the Cu $K\alpha_2$ lines yields a wavelength conversion factor from angstrom to thousand x units of Λ = 1.002057 Å/kxu ± 5 ppm. Recalculation of the best measurements in the literature with current values of the atomic weights gave values which agree with the present work within probable errors. Plane-ruled-grating measurements of x-ray wavelengths yield a value of Λ = 1.00203 ± 30 ppm, which is lower than the above values, but the probable errors overlap. (auth)

34341 PRECISION REDETERMINATION OF STANDARD REFERENCE WAVELENGTHS FOR X-RAY SPECTROSCOPY. J. A. Bearden, Albert Henins, John G. Marzolf, William C. Sauder, and John S. Thomsen (Johns Hopkins Univ., Baltimore). Phys. Rev., 135: A899-901(Aug. 17, 1964).

This investigation is designed to determine with high accuracy the wavelength ratios of 5 standard x-ray reference lines: Cr $K\alpha_2$, Cu $K\alpha_1$, Mo $K\alpha_1$, Ag $K\alpha_1$, and W $K\alpha_1$. Most measurements were obtained with a double-crystal spectrometer in reflection. However, a few were taken with the instrument converted to a high-precision single-crystal spectrometer, and some tungsten determinations were made in transmission. Since estimated errors (±1 ppm) are the lowest ever claimed for this type of work, the apparatus, including adjustment, calibration, and corrections, are described in considerable detail. Novel features include: use of a high-intensity, narrow-focus rotating-target tube for most measurements, calibration of the spectrometer circle to 0.1 sec with an angular interferometer, and a careful selection of 5 crystals (1 calcite, 2 quartz, and 2 silicon) from more than 100 samples tested. Bragg angles were determined for 20 different combinations of crystals and wavelengths. With an assumed wavelength value for one selected line, this gave an overdetermined set of 20 equations for 9 unknowns (4 wavelengths and 5 grating constants), which was solved by a least-squares adjustment. If the value for Mo $K\alpha_1$ is provisionally taken as 707.831 xu, the resulting values for the other wavelengths are: Cr $K\alpha_2$, 2288.854 ± 0.003 xu; Cu $K\alpha_1$, 1537.370 ± 0.002 xu; Ag $K\alpha_1$, 558.2486 ± 0.0006 xu; W $K\alpha_1$, 208.5770 ± 0.0003 xu. However, the primary quantities determined are the wavelength ratios, which are invariant with respect to a choice of the primary defining reference line. The question of adopting a definitive standard is left open for the present. (auth)

34342 LINEARIZED MANY-BODY PROBLEM. Nobuyuki Fukuda (Brandeis Univ., Waltham, Mass.), Fumiaki Iwamoto, and Katuro Sawada. Phys. Rev., 135: A932-44 (Aug. 17, 1964).

The theory of an electron gas at high density is generalized so as to include the exchange scattering of a particle and hole in the singlet as well as in the triplet spin state. This approximation is the maximum possible linearization of a quantum-mechanical many-body problem and corresponds to the theory of small-amplitude oscillations of a classical many-body system. The linearized hamiltonian is that of Wentzel's meson pair theory, in which now two kinds of mesons are involved, one with spin zero corresponding to the singlet state of a particle and hole and the other with spin one corresponding to the triplet state. The correlation energy is shown to be the sum of the change in zero-point energies of the two-meson fields with correction only in the second-order term. The theory is then formulated in terms of Green's function, and it is proved explicitly that the linearized theory (or the random-phase approximation with exchange effects taken into account) is equivalent to the ladder approximation for the particle-hole scattering. The particle-particle scattering by means of the screened interaction is also discussed. The case of the δ-function potential is explicitly solved, and it is shown that the correlation energy becomes complex in the region where the instability of the paramagnetic state occurs. (auth)

34343 MOBILITY OF POSITIVE IONS IN LIQUEFIED ARGON AND NITROGEN. Bob L. Henson (Washington Univ., St. Louis). Phys. Rev., 135: A1002-8(Aug. 17, 1964).

Drift velocities of positive ions in liquid argon and liquid nitrogen were measured for applied electric fields in the range from 0 to 4300 v/cm. These data were taken at pressures of 1 atm and at temperatures corresponding to the respective liquids' boiling points at this pressure. A time-of-flight spectrometer, consisting of an ion source, an electronic shutter, and a final drift space, was used. The ions were produced by the technique of field ionization. This was accomplished by immersing a tungsten point (etched down to a radius of less than 1000 Å) in the respective liquefied gases and applying a high potential to it. The times of flight of the ions across the final drift space were determined by amplifying the ion current and displaying it on an oscilloscope. It was found that step-like changes in the curves of ion mobility versus E occurred in both liquid argon and liquid nitrogen. Five such constant-mobility regions were found in liquid argon and four in liquid nitrogen. These constant mobilities were found to be 6.0×10^{-4}, 9.75×10^{-4}, 8.50×10^{-4}, 7.75×10^{-4}, and 7.25×10^{-4} cm^2/v-sec in liquid argon, and 2.50×10^{-3}, 1.80×10^{-3}, 1.54×10^{-3}, and 1.36×10^{-3} cm^2/v-sec in liquid nitrogen. It is suggested that these mobilities may correspond to ionic clusters. (auth)

34344 PERTURBATION CORRECTION TO THE RADIAL DISTRIBUTION FUNCTION. F. Lado (Univ. of Florida, Gainesville). Phys. Rev., 135: A1013-17(Aug. 17, 1964).

The effect on the radial distribution function g(r) of adding a small, long-range interaction to a short-range po-

tential is investigated. Two equations are obtained for the corrected g, corresponding to approximations similar to those used in obtaining the Percus-Yevick and convolution hypernetted chain integral equations. The equations relate the short-range g (assumed known) and the long-range perturbing potential to the g corresponding to the complete potential. These equations and equations previously obtained by Broyles, Sahlin, and Carley and Hemmer were tested numerically for a model having a negative Gaussian-Mayer f function, for which near-exact solutions are available from the work of Helfand and Kornegay. (auth)

34345 VAN DER WAALS FORCES FOR THE INERT GASES. A. E. Kingston (Univ. of Colorado, Boulder). Phys. Rev., 135: A1018-19(Aug. 17, 1964).

Theoretical and experimental values of electric-dipole oscillator strengths for inert-gas atoms are analyzed to yield a set of oscillator strengths, which satisfy the Thomas-Kuhn sum rule, and which reproduce the experimental refractive indices and Verdet constants. These oscillator strengths are then used to calculate the long-range van der Waals interaction between all pairs of atoms selected from helium, neon, argon, krypton, and xenon. The derived interaction constants are probably in error by less than 10%. They disagree with the currently accepted values of the interaction constants. (auth)

34346 PERTURBATION APPROACH TO THE DIFFRACTION OF ELECTROMAGNETIC WAVES BY ARBITRARILY SHAPED DIELECTRIC OBSTACLES. C. Yeh (Univ. of Southern California, Los Angeles). Phys. Rev., 135: A1193-1201(Aug. 31, 1964).

A perturbation method is developed to consider the problem of the diffraction of electromagnetic waves by an arbitrarily shaped dielectric obstacle whose boundary may be expressed in the general form, in spherical coordinates, $r_p = r_0[1 + \delta f_1(\theta,\phi) + \delta^2 f_2(\theta,\phi) + \ldots]$ where r_0 is the radius of an unperturbed sphere and $f_n(\theta,\phi)$ are arbitrary, single-valued and analytic functions. δ is chosen such that $\sum_n |\delta^n f_n(\theta,\phi)| < 1$, $0 \le \theta \le \pi$, $0 \le \phi \le 2\pi$. Detailed analysis is carried out to the first order in δ. Procedures to obtain higher order terms are also indicated. The perturbation solutions are valid for the near zone regions of the obstacle as well as for the far zone region and they are applicable for all frequencies. Possible applications of this perturbation technique to elementary-particle scattering problems and other electromagnetic scattering problems are noted. (auth)

34347 APPLICATION OF A KINETIC MODEL TO TIME-DEPENDENT DENSITY CORRELATIONS IN FLUIDS. Sidney Yip and Mark Nelkin (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 135: A1241-7(Aug. 31, 1964).

The kinetic model of Bhatnagar, Gross, and Krook is used to study the double Fourier transform of the time-dependent density correlation function G(r,t). The results are appropriate to a dilute fluid for arbitrary ratio of wavelength to mean free path. The results of the model calculations are compared to those derived from the linearized hydrodynamic equations. Since neutron and light-scattering experiments can be analyzed in terms of G(r,t), this comparison indicates that the hydrodynamic description should be applicable for momentum transfers less than $(\hbar/2\lambda)$, where λ is the collision mean free path in the fluid. (auth)

34348 RADIATION SCATTERED FROM THE PLASMA PRODUCED BY A FOCUSED RUBY LASER BEAM. S. A. Ramsden and W. E. R. Davies (National Research Council, Ottawa). Phys. Rev. Letters, 13: 227-9(Aug. 17, 1964).

The scattering of a laser beam from the plasma produced by gas (air and helium) breakdown by the beam was observed. The wavelength of the scattered radiation was shifted slightly with respect to that of the laser beam. This was interpreted as a Doppler shift due to motion of the plasma during the initial phase of the spark. (D.C.W.)

34349 TRANSPORT EQUATION OF A BROWNIAN PARTICLE IN AN EXTERNAL FIELD. P. Resibois and H. T. Davis (Université Libre, Brussels). Physica, 30: 1077-91(June 1964).

The general theory of irreversible processes developed by Prigogine is applied to the particular problem of the motion of a heavy charged particle (mass M) moving in a fluid of light particles (m; $\gamma = (m/M)^{1/2} \ll 1$) under the influence of an external electric field. The results obtained recently by Lebowitz, using a completely different technique, are recovered; to the lowest order in γ, the Brownian particle obeys a Fokker-Planck equation. The higher order corrections are also discussed, and special attention is focused on the effect of the field during a collision process between the Brownian particle and the fluid. This effect can, however, be incorporated in a velocity dependent correction to the Fokker-Planck collision term. (auth)

34350 THEORY OF THE ELECTRICAL BREAKDOWN OF GASES BY INTENSE PULSES OF LIGHT. J. K. Wright (Central Electricity Research Labs., Leatherhead, Surrey, Eng.). Proc. Phys. Soc. (London), 84: 41-6(July 1964).

It was recently shown that gases may be broken down by the intense electromagnetic radiation of focused laser beams. The theory of this type of breakdown is described. The mechanism analyzed is that in which an electron acquires energy from the radiation field by inverse bremsstrahlung absorption. When it has gained sufficient energy, the electron collides inelastically with a gas atom. In some cases this will cause ionization, but in most cases the atom will be excited to a higher level. Photoionization by the absorption of a number of photons from the light pulse rapidly ensues. In this way the electron population multiplies exponentially. There is reasonable agreement between this theory and previously published experimental results. (auth)

34351 POSITIVE ION MOBILITIES AND CONVERSION RATES IN A HELIUM AFTERGLOW. R. Hackam and J. J. Lennon (Univ. of Liverpool). Proc. Phys. Soc. (London), 84: 133-9(July 1964).

An X-band (3 cm) microwave cavity method was used to measure the electron loss rate in the afterglow of a pulsed discharge in helium. Further purification of spectroscopically pure gas samples was undertaken to give more reliable results and afterglow periods up to 60 msec were investigated. The positive ion reduced mobility μ_0 (as deduced from a measurement of the ambipolar diffusion coefficient) was found to be constant at 16.7 ± 0.5 cm^2 v^{-1} sec^{-1} in the pressure range 4–83 mm of Hg, and this is attributed to the molecular ion He_2^+. Measurements at pressures below 4 mm of Hg indicated the presence of both atomic and molecular ions, and an extrapolation to zero pressure yielded a figure of 10.6 cm^2 v^{-1} sec^{-1} for the mobility of the atomic species He^+. The frequency of conversion of atomic into molecular ions by three-body collisions was found to be $115p^2$ sec^{-1} in good agreement with theory. (auth)

34352 THE DISPLACEMENT ENERGY IN GaAs. J. A. Grimshaw and P. C. Banbury (Univ. of Reading, Eng.). Proc. Phys. Soc. (London), 84: 151-62(July 1964).

Hall effect and resistivity measurements were made on single-crystal, n-type samples of GaAs irradiated by elec-

trons with energies of 0.4 to 1.0 Mev at liquid nitrogen temperature. Results were compared with predictions from the theory for displacement of lattice atoms based on a sharp threshold model. Acceptable agreement is obtained for both the energy dependence and the order of magnitude of the removal rate of conduction electrons, assuming a displacement energy of 17 to 18 ev. This result is compared with the minimum energy for displacements of about 9 ev found by von Bauerlein. Calculations are included for secondary displacements using the assumptions of Harrison and Seitz, but it seems unlikely on this model that all the effects observed are caused by secondary events. The nature of the displacement process is briefly considered. (auth)

34353 BOPP'S APPROXIMATION TO THE ENERGY OF AN N-ELECTRON SYSTEM. T. B. Grimley (Univ. of Liverpool). Proc. Phys. Soc. (London), 84: 178-80(July 1964).

A faulty discussion by Bopp leading to an alleged lower bound for the energy of an n-electron system suggests a simple approximate formula for the ground-state energy. Calculations for the series of ions Be^{+} to Ar^{8+} yield results with an accuracy to about 2%. (auth)

34354 DYNAMICAL DIFFRACTION OF X RAYS BY PERFECT CRYSTALS. Boris W. Batterman (Bell Telephone Labs., Inc., Murray Hill, N. J.) and Henderson Cole. Rev. Mod. Phys., 36: 681-717(July 1964).

The dynamical theory of x-ray diffraction from perfect crystals is reviewed and is used to explain the observed effects. (D.C.W.)

34355 THE SOLID STATE OF RARE GASES. Gerald L. Pollack (National Bureau of Standards, Washington, D. C.). Rev. Mod. Phys., 36: 748-91(July 1964).

The experimental and theoretical literature on the structure, melting, crystallization, and thermodynamic properties of solid rare gases is reviewed. 254 references. (D.C.W.)

34356 TWO-DIMENSIONAL ISING MODEL AS A SOLUBLE PROBLEM OF MANY FERMIONS. T. D. Schultz (International Business Machines Corp., Yorktown Heights, N. Y.), D. C. Mattis, and E. H. Lieb. Rev. Mod. Phys., 36: 856-71(July 1964).

An attempt is made to reduce the algebraic solution of the Ising model on a square lattice to a sequence of simple steps. The transfer matrix is diagonalized using the formalism of second quantization for fermions. (D.C.W.)

34357 METHOD OF CONTINUOUS SHOCK FRONT POSITION MEASUREMENT. M. Heusinkveld and F. Holzer (Univ. of California, Livermore). Rev. Sci. Instr., 35: 1105-7(Sept. 1964). (UCRL-7449(Rev.I))

A method (called "slifer") for continuously measuring the position of a shock front in a solid, opaque medium was developed. The sensing element is a shorted transmission line which forms part of the inductance of an oscillator. As the stress wave moves along the line, it crushes the cable progressively, thus changing the cable inductance and the oscillator frequency. The oscillator output is recorded as a function of time. This frequency record is converted to uncrushed cable length, and finally to a position versus time relation. (auth)

34358 ON THE PROBLEM OF OPTIMUM CONDUCTIVITY DISTRIBUTION IN A FLUID FLOWING IN EXTERNAL MAGNETIC FIELD. K. A. Lur'e. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 2, 29-39(Mar.-Apr. 1964). (In Russian)

The optimum distribution of conductivity of a fluid in motion in an external magnetic field alternating along the x coordinate was calculated. (R.V.J.)

34359 HEAT TRANSFER IN A CONDUCTING FLUID FLOW AT SMALL REYNOLDS MAGNETIC NUMBER. I. I. Novikov and L. D. Pichakhchi. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 3, 143-5(Mar.-Apr. 1964). (In Russian)

A series of approximation equations were obtained for heat transfer in a conducting incompressible flow in a laminar boundary layer in the presence of a magnetic field and with Reynolds numbers $R_m < 1$. (R.V.J.)

34360 MAGNETOHYDRODYNAMIC SHOCK WAVES. J. Edward Anderson. Cambridge, Mass., Massachusetts Institute of Technology Press, 1963. 238p. $6.50.

The stability of steady-state MHD shock waves considered as discontinuities in a perfect fluid is investigated with respect to breakup due to small flow perturbations, together with the existence, uniqueness, and qualitative behavior of the steady-state shock layer. (D.C.W.)

34361 IMPURITY EFFECTS ON THE IONIZATION RATE IN XENON SHOCK WAVES. Bert Zauderer (General Electric Co., King of Prussia, Pa.). 3p. (CONF-542-5)

From 5th Symposium of the Engineering Aspects of Magnetohydrodynamics, Cambridge, Mass., Apr. 1964.

The effect of impurity concentration on the ionization rate behind a Xe shock with and without an applied magnetic field in the MHD generator was studied. Small amounts of O_2, N_2, and H_2 were added to the Xe. The diatomic impurities increased the ionization rate and electric conductivity behind the shock independently of the type of impurity. A transverse magnetic field produced a further conductivity increase which varied with the impurity level. In pure Xe the induced electric fields in the generator raise the conductivity, while at high impurity levels shocks induced by Lorentz force cause the increase. Notably, the conductivity increase is very sensitive to minute diatomic impurities. (D.C.W.)

34362 EXPERIMENTAL STUDY ON THE EMISSION OF CYCLOTRON-HARMONICS. Gerd Landauer (Max-Planck-Institut fur Physik und Astrophysik, Munich). 13p. (CONF-471-33)

From American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963.

Cyclotron emission up to the forty-fifth harmonic of the electron gyrofrequency from a Penning discharge was observed using two separate microwave horns (34.4 Bc) with their axes parallel and perpendicular to the external magnetic field. The measurements were made by varying the magnetic field and show a relative line width $\Delta B/B \gtrsim 2\%$ of each harmonic. Inhomogeneities of the magnetic field cause severe broadening of the lines as expected. The harmonic emission was also measured over the frequency range from 30 to 37 Bc for several constant magnetic field values. (auth)

34363 EXACT CRITERION OF HYDROMAGNETIC STABILITY OF INVISCID VORTEX FLOW WITH FINITE CONDUCTIVITY. Tien Sun Chang (Virginia Polytechnic Inst., Blacksburg, Va.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-435, 6p. $1.00. (CONF-600-31)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

An analysis considering the stabilization of an inviscid pure-vortex flow with finite conductivity by means of an axially applied magnetic field is presented. If it is assumed that the marginal state of stability is due to a secondary stationary flow and the conductivity of the medium is not

negligible, then an exact criterion for magnetic stabilization may be deduced. The marginal magnitude of the axially applied magnetic field for stability is related to the radius ratio, the density of the fluid, and the peripheral speed of the vortex. It is related indirectly to the finite conductivity of the fluid medium. Under the stated assumptions, the stability criterion is equivalent to the result obtained for a medium with infinite conductivity. (auth)

34364 TRANSIENT MOTION OF SPACE CHARGE THROUGH A NEUTRAL GAS. Anthony Demetriades and Jack H. Hill (California Inst. of Tech., Pasadena). 34p. (CONF-471-35)

From American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963.

The history of motion of charge carriers generated in a gap by ionizing radiation is investigated. The study is limited to cases where the field-induced motion of these carriers overcomes their inertia and diffusion; the motion is thus completely collision-dominated. The severity of the space-charge effect is described by a single nondimensional parameter γ. When γ is not much smaller than unity, usual linearization procedures are inapplicable. The nonlinear problem is solved for two limiting cases: in the electron-ion conduction mode the electric current is carried by the free electrons and ions as originally created When all the electrons attach themselves on neutrals to form negative ions, an ion-ion mode is considered. Exact analytic solutions are supplemented by computer solutions to give the charge density and electric field distributions and current histories for $\gamma \lesssim 2$ in the electron-ion mode, and for $\gamma < 10$ in the ion-ion mode. (auth)

Accelerators

34365 (BNL-8145) HIGH-ENERGY SEPARATED BEAM FOR THE 80" CHAMBER. Status Report. Ian Skillicorn and Medford S. Webster (Brookhaven National Lab., Upton, N. Y.). Mar. 21, 1962. Contract AT-30-2-GEN-16. 28p.

Design considerations are given for a beam transport system to be used with the Brookhaven AGS to obtain separated beams of K mesons at 3 to 5.5 Bev/c and of antiprotons to 8.5 Bev/c. (R.E.U.)

34366 (BNL-8166) DISPLAY-ORIENTED DATA SIMULATION AND ANALYSIS IN MULTIPARAMETER EXPERIMENTS. James F. Mollenauer (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT-30-2-GEN-16. 14p. (CONF-593-2)

From Conference on the Automatic Acquisition and Reduction of Nuclear Data, Karlsruhe, Ger., July 1964.

The SDS 910 system in use with the BNL 60-inch cyclotron is described. General aspects of using computers for multiparameter data analyses are discussed. (R.E.U.)

34367 (CEAL-1000) THE CAMBRIDGE ELECTRON ACCELERATOR: A COMPREHENSIVE ACCOUNT. W. A. Shurcliff, ed. (Cambridge Electron Accelerator, Mass.). Mar. 1, 1964. Contract [AT(30-1)-966]. 246p.

The history, philosophy of design, actual design, construction, and early operation of the 6-Bev electron synchrotron are summarized. Auxiliary facilities as well as major accelerator components are described. The magnet system, injector linac, vacuum systems, shielding, beam stabilizing components, and cryogenic system are discussed. (R.E.U.)

34368 (CERN-64-29) DIFFUSION COULOMBIENNE EN MILIEU FOCALISANT. PROGRAMMES FORTRAN (CERN W101–B51 ET B58). (Coulomb Scattering in Focusing Media. Fortran Programs (CERN W101–B51 and B58)). J. Banaigs, A. Citron, J. Fronteau, and J. Hornsby (European Organization for Nuclear Research, Geneva). June 15, 1964. 46p.

The B51 and B58 programs for IBM 709 relative to Coulomb scattering in focusing media are described. The B51 program calculates the standard deviations of Coulomb scattering in focusing media. The method is described, and the formalism is very similar to that of B50. The problem consists of studying the intensity loss of a beam due to multiple electromagnetic scattering. Nuclear scattering is completely ignored. The program is then applied to the μ component of the secondary beam. The B58 program calculates the transmission spectrum of a beam. Examples are given of the application of both programs. (J.S.R.)

34369 (JINR-P-1681) FOKUSIRUYUSHCHIE SVOISTVA SHESTIPOL'NOGO MAGNITA. (Focusing Properties of a Sextupole Magnet). Yu. A. Plis (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 20p.

Magnetic lenses used to focus neutral atoms in a polarized particle source are considered. The sextupole is shown to have better properties than the quadrupole. The calculation results performed with an electronic computer in order to determine the optimal dimensions of the sextupole are cited. The recommendations for lens construction are given. The intensity of polarized atoms under optimal conditions is evaluated. (auth)

34370 (LAL-1110) LES ANNEAUX DE STOCKAGE A ELECTRONS. (Storage Rings for Electrons). G. Gendrem (Paris. Université, Orsay. École Normale Supérieure. Laboratoire de l'Accélérateur Linéaire). June 1964. 25p.

The theory and utilization of electron storage rings are reviewed. Special problems of storage rings are discussed. The reasons for the wide interest in storage rings are the energy available and the possible types of interactions. The functioning of storage rings is described by a consideration of the mechanism for the accumulation of particles, rate of counting e^+e^- and e^-e^- interactions, and limitations in the number of particles accumulated. The characteristics of existing and planned storage rings are discussed, and the 450-Mev storage ring at Orsay for electrons and positrons is described. Space-charge effects and radiative losses are considered. (J.S.R.)

34371 (NP-13986) ENTWICKLUNG EINES 100-Mev FFAG-ELEKTRONENSYNCHROTRONS. EIN IN DIE VAKUUMKAMMER EINGEBAUTER BREITBAND-BESCHLEUNIGUNGSRESONATOR. (Development of 100-Mev FFAG Electron Synchrotrons. A Broad-Band Accelerator Resonator Installed in the Vacuum Chamber). D. Moehl (Berlin. Freie Universitat. I. Physikalisches Institut). Jan. 21, 1964. 11p.

The investigations briefly described in Report No. 11 were concluded. An outline of the calculations and measurements was compiled. After conclusion of the measurement in synchronization of the eigenfrequency f_0 of the resonator to the cycle frequency f_t of the particle, the frequency behavior in synchronization to the doubled value of the cycle frequency ($f_0 = 2\ f_t = 57$ MHz) was further investigated and the electrical properties of the system divided up into partial resonators was experimentally determined. The scattering field at the electrode boundary was measured by a method developed for that purpose. In the undivided system suitable working conditions were derived for the range 28 MHz (decrease of the acceleration voltage

over the gas A = $(U_{max} - U_{min})/U_{max} < 5\%$) and 57 MHz ($A \leq 10\%$). Complications caused by scattering fields at the injection radius and final radius were avoided by slight radial broadening of the chamber. By dividing up the system, whose internal conductor can be extended over partial stages of the radius intervals, perturbations of the acceleration process are, on the other hand, to be expected by additionally occurring scattering fields. (tr-auth)

34372 (SLAC-30) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, January 1–March 31, 1964. (Stanford Univ., Calif. Stanford Linear Accelerator Center). June 1964. Contracts AT(04-3)-400 and AT (04-3)-515. 86p.

The development of a two-mile-long linear electron accelerator (20 Bev, 30 μamp) by Stanford University is summarized, with reference to the following topics: plant engineering; accelerator structures; development and fabrication of klystrons, electronics, and microwave systems; microwave injection studies; systems engineering and installation; operation and modifications in the Mark IV prototype; and pre-operation research and development. (T.F.H.)

34373 (JPRS-25692) THE 600-KILOVOLT ELECTROSTATIC ACCELERATOR AT THE SCHOOL OF ENGINEERING IN SPLIT. Nikola Cindro. Translated from Tehnika (Belgrade), No. 6, 1011-14(June 1964). 10p. (TT-64-31964)

The working principles and technical characteristics of the electrostatic Van de Graaff 600-kv accelerator at the Jozef Stefan Institute in Ljubljana for the School of Electrical Engineering in Split are discussed. The basic technical specifications are: maximum voltage of the source, 650 kv; stream of deuterons on the target, more than 50 μamp; and a beam diameter on the target of 3 mm ϕ. The device will be used for studying nuclear reactions caused by particles of less than 1 Mev, and for the production of neutrons and high-energy gamma rays. It will also be used for studying the effects of electrons on the properties of polymers. A source of electrons is expected to be installed for this purpose. (auth)

34374 TECHNIQUE FOR THE EXPERIMENTAL STUDY OF MATERIAL SHIELDING PROPERTIES IN THE PROTON DUBNA SYNCHROCYCLOTRON. V. P. Afanas'ev, I. B. Keirim-Markus, E. E. Kovalev, V. A. Sakovich, L. N. Smirennyi, and M. A. Sychkov. At. Energ. (USSR), 16: 437-40(May 1964). (In Russian)

In connection with the growing interest in the calculation and design of high-energy proton shielding, the feasibility is surveyed of a study of the shielding properties of various materials, using a collimated bunch of protons obtained in the synchrocyclotron at JINR. A method of transfer from narrow-beam to wide-beam geometry is substantiated. Possible methods of registering the size of the dose from the shielding are considered. A method used for obtaining monoenergetic bunches of protons with energies from 100 to 660 Mev is described. The characteristics of the obtained bunches are presented, and, on the basis of experimental data, the neutron impurities in the exit bunch are estimated. (tr-auth)

34375 STUDY OF TRITIUM-LOADED THIN TARGETS USED IN ACCELERATORS PRODUCING FAST NEUTRONS BY THE REACTION T(d,n). Francis Cambou and Henri Rème (Faculté des Sciences, Toulouse). J. Phys. (Paris), 25: Suppl. to No. 3, 61A-3A(Mar. 1964). (In French)

The yields of seventeen T–Ti targets were measured at constant deuteron beam current and energy and as a function of irradiation time. The lives of the targets at a high neutron flux were also studied. The reasons for an observed restricted efficiency were determined by a thermodynamic study of the targets. (D.C.W.)

34376 ANALYTIC DETERMINATION OF THE POLAR PROFILE OF THE MAGNET OF THE SYNCHROCYCLOTRON FOR A FIXED INDUCTION GRADIENT. J. Lafoucrière and B. Tournissou (Institut de Physique Nucleaire, Lyon). J. Phys. (Paris), 25: Suppl. to No. 3, 64A-6A(Mar. 1964). (In French)

An empirical method of correcting magnetic induction is applied to shimming calculations for the synchrocyclotron of the Institute of Nuclear Physics. The results are in good agreement with the pole profile proposed by the builder. (auth)

34377 SOME CHARACTERISTICS OF A DUOPLASMATRON ION SOURCE. Hiroyuki Tawara (Hitachi Ltd., Ibaraki, Japan). Japan. J. Appl. Phys., 3: 342-6(June 1964).

A duoplasmatron ion source capable of producing a hydrogen ion beam of about 10 mamp was constructed and tested. The effect of a resistance which connects the intermediate electrode and the anode was studied. The ratio of the anode current to the total arc current is strongly influenced by the value of the resistance. It is shown that the intermediate electrode of the duoplasmatron ion source plays the same role as the grid of an electron tube or the ignitor of a mercury rectifier. By changing the resistance periodically, a high-intensity pulsed ion beam was obtained from the duoplasmatron ion source. (auth)

34378 RESONANT DEPOLARIZATION OF DEUTERONS DURING ACCELERATION IN A SECTOR-FOCUSED CYCLOTRON. Ho Gil Kim and W. E. Burcham (Univ. of Birmingham, Eng.). Nucl. Instr. Methods, 27: 211-20(May 1964).

The calculation of depolarization for particles of spin 1 undergoing cyclic acceleration is considered. Depolarization may occur when certain relations between the vertical and horizontal oscillation frequencies in the accelerator and the spin precession frequency in the main magnetic field are satisfied. In the relativistic case the spin precession frequency depends on the particle energy and anomalous magnetic moment. The calculations are applied for the case of deuterons in the 3-sector 40-in. cyclotron, and it is shown that depolarization is negligible if the radial field gradient and the first order azimuthal field harmonic are kept small. (auth)

34379 BEAM STABILITY IN DC-PUMPED CYCLOTRON SYNCHRONOUS WAVE AMPLIFIERS. J. C. Bass (Univ. of Sheffield, Eng.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 52: 843(July 1964).

A simple theory of beam stability is outlined; and theoretical predictions on stability limits are given, together with the results of an experiment on beam expansion in a twelve-element electrostatic pump. (D.C.W.)

34380 A SURVEY OF THE 60° BEAM AT THE PRINCETON-PENNSYLVANIA ACCELERATOR. A. Berick, D. Hansen, C. Ward, and C. York (Univ. of California, Los Angeles). 40p. (CONF-452-32)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

A mass analysis was made of the relatively long-lived particles emitted at a laboratory angle of 60° from a beryllium target when bombarded with 3-Bev protons. The mass separation was accomplished by applying a time-of-flight measurement to the particles in a momentum-analyzed beam. The momentum spectra for positive and

negative mesons(π), protons, deuterons, and tritons are presented in the range from 200 to 1600 Mev/c. No appreciable numbers of mesons(K) were observed in this beam. (auth)

34381 THE PRODUCTION OF INTENSE NEGATIVE HELIUM AND HYDROGEN ION BEAMS. N. B. Brooks, P. H. Rose, A. B. Wittkower, and R. P. Bastide (High Voltage Engineering Corp., Burlington, Mass.). 18p. (CONF-452-24)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

The source and experimental arrangement used for the production and measurement of 830 μamp of negative hydrogen ions is described. (auth)

Astrophysics and Cosmology

Refer also to abstract 34932.

34382 (NP-14141) THE RELATIVE ABUNDANCES OF ENERGETIC HYDROGEN ISOTOPES PRODUCED IN SOLAR FLARES. C. J. Waddington and P. S. Freier (Minnesota. Univ., Minneapolis). June 1964. Contract Nonr-710(60). 22p. (CR-71)

The relative abundances of protons, deuterons, and tritons were studied in photographic nuclear emulsions flown during the July 18th, 1961 solar flare event. These emulsions were exposed at a time and locality where there was a geomagnetic threshold, and the consequent enrichment of the abundance ratios was used to reduce the abundance limits to lower values than those previously quoted. By including the results of previous α-particle measurements in these emulsions, it was found that the relative abundances of solar-produced ^1H, ^2H, ^3H, and He above a given rigidity at this time were 1: $\leq 1.4 \times 10^{-2}$: $\leq 2.8 \times 10^{-2}$: 0.17, and above an energy of 50 Mev per nucleon, i.e., above a given velocity, were 1: $\leq 2 \times 10^{-3}$: $\leq 6 \times 10^{-4}$: 2.4×10^{-2}. The consequences of these observations are discussed. (auth)

34383 (NASA-TT-F-229) INVESTIGATION OF THE UPPER LAYERS OF THE ATMOSPHERE AND SPACE. A Bibliography. Translation of "Issledovaniye Verkhnikh Sloyev Atmosfery i Kosmicheskogo Prostranstva," from Bibliog. Byull., Vses. Inst. Nauchn. i Tekhn. Inform., No. 2, 3-46(1964). 70p.

Bibliographical material is presented on the following subjects: structure and composition of upper layers of the atmosphere, atmospheric luminescence, ionosphere, radiowave propagation, permanent and variable magnetic fields, radiation belts, solar activity, cosmic rays, meteorites and meteors, moon and planets of the solar system, and space biology and medicine. An index of authors is also included. 515 entries. (NASA)

34384 NEON VII AND VIII WAVELENGTHS IN THE VACUUM ULTRAVIOLET. Lewis L. House (High Altitude Observatory, Boulder, Colo.) and George A. Sawyer. Astrophys. J., 139: 775-6(Feb. 15, 1964). (LADC-6118)

Preliminary results of a study of the spectra of highly ionized atoms produced in plasmas, to obtain data which would aid in the identification of lines observed in recent rocket ultraviolet spectra of the sun, are reported. New vacuum ultraviolet wavelengths for neon VII and VIII, obtained by "salting" a high energy plasma with neon, are tabulated. (L.B.S.)

34385 ABUNDANCES IN K GIANT STARS. I. A DETERMINATION OF THE ABUNDANCES IN THE HYADES K GIANTS. H. L. Helfer (Univ. of Rochester, N. Y.) and George Wallerstein. Astrophys. J., Suppl. Ser., 9: 81-106 (Aug. 1964).

Differential curve-of-growth abundance analyses for the Hyades K giants, γ, δ, and ϵ Tauri are presented, the Sun being used as the reference star. The conventional type of analysis results in a consistent model with abundances that do not agree with abundances previously found applicable to the Hyades G dwarfs. The requirement that the K giants should have the same abundances as the G dwarfs forces a modification of the reduction procedure. Treatment of the neutral and the ionized lines separately, corresponding effectively to adoption of a two-level atmosphere, permits successful recovery of the Hyades G dwarf abundances. The derived atmospheric parameters appear reasonable. The increase of complexity in the analysis apparently results from the difficulty of assigning levels in the solar atmosphere to line formation. The only abundance anomalies found are: (1) in δ Tauri, Zr is definitely deficient by a factor of 2, relative to Fe, and Y, Sc, Ba, La, Ce, Eu, and Pr may also be slightly underabundant; (2) there is a possibility that Na may be slightly overabundant and the rare earths slightly underabundant in all three stars. The observational data are used to provide a mean curve of growth and log η values for future differential curve-of-growth analyses of K giants, using the Hyades K giants as reference stars. This mean curve of growth is necessarily bifurcated. The mean curve of growth and the K star log η values have been applied to analysis of abundances in θ^1 Tauri and in ϵ Virginis. The abundances found for θ^1 Tauri agree with the abundances found for the other Hyades K giants and the abundances found for ϵ Virginis agree with those found by Cayrel and Cayrel (1963). (auth)

34386 THE EVOLUTION OF MASSIVE STARS INITIALLY COMPOSED OF PURE HYDROGEN. R. Van Der Borght (Australian National Univ., Canberra). Australian J. Phys., 17: 165-74(June 1964).

The amount of carbon formed during the pre-main-sequence contraction of massive stars initially composed of pure hydrogen is evaluated for masses ranging from 40 to 120M. The evolution of the stars during the hydrogen burning phase is followed, and the variation of carbon content with time is obtained. (D.C.W.)

34387 QUIET DAY SOLAR DAILY MAGNETIC VARIATIONS AT TOOLANGI, VICTORIA. D. E. Winch and L. Slaucitajs (Univ. of Sydney). Australian J. Phys., 17: 189-99(June 1964).

The results of an analysis of the quiet day solar daily magnetic variations (S_q) of all magnetic elements as recorded at Toolangi Observatory, Victoria, during the years 1949–1958 are given as well as the times of occurrence of extrema and the percentage contributions of each harmonic to each extrema. Comparison of times of occurrence of the extrema indicates that the extrema in ΔX and ΔY occur about 10 min earlier in years of high sunspot activity than in years of low sunspot activity, and vice versa for ΔZ. Graphs of S_q in ΔX, ΔY, and ΔZ are included. (auth)

34388 SOLAR PROTONS AND THEIR GEOPHYSICAL EFFECTS. S. M. Krimigis (State Univ. of Iowa, Iowa City). Proc. Iowa Acad. Sci., 70: 393-402(1963).

The present state of knowledge of solar particle emission is given, and the effect of this emission in geophysical phenomena is analyzed. It is pointed out that the particle emission can be categorized into continuous plasma emission and occasional emission of solar cosmic rays. The plasma emission mainly determines the shape of the magnetospheric boundary, whereas the cosmic ray emission

accounts for the geomagnetic storms, intense aurorae, ionization of the upper atmosphere, and Forbush decreases in the primary cosmic radiation. In addition, some of the remaining fundamental questions to be investigated in the future are pointed out. (auth)

34389 SOLAR FLARE HIGH ENERGY ALPHA PARTICLES AND THEIR STORAGE IN INTERPLANETARY SPACE. G. Kenneth Yates (Univ. of Chicago). J. Geophys. Res., 69: 3077-95(Aug. 1, 1964).

A scintillation counter telescope and a Čerenkov counter in a high-altitude balloon measured the relativistic alpha particle flux in the late stages of the November 12-13, 1960, solar flare event. The integral solar alpha particle flux was found to be 55 part/sec m^2 ster for kinetic energies greater than 560 Mev/nucleon (R > 2.3 Bv). Combined with the results of Biswas, Fichtel, and Guss (31 < E < 112 Mev/nucleon) obtained at the same time, the data are consistent with a differential kinetic energy spectrum $\propto E^{-4}$ or a differential magnetic rigidity spectrum $\propto R^{-7}$ and do not agree with an exponential magnetic rigidity spectrum. The time variation of the relativistic solar alpha particles observed indicates that early in the event the particles initially trapped in the region between the two "fronts" associated with the Forbush decreases also leaked backward into the region between the second front and the sun. At the time of measurement, the fluxes in the two regions were approximately equal, and the net flux across this second front was insignificant. (auth)

34390 RARE GASES IN THE CHONDRITE RENAZZO. J. H. Reynolds and G. Turner (Univ. of California, Berkeley). J. Geophys. Res., 69: 3263-81(Aug. 1, 1964).

The rare gas content of the chondrite Renazzo was determined. Fractions of different isotopic composition were separated by heating the sample to successively higher temperatures. The abundance and isotopic composition of the gases is similar to that in the carbonaceous chondrite Murray, with a high percentage of so-called primordial gas. For the light rare gases this primordial component appears to be highly fractionated with respect to the supposed cosmic isotopic ratios. Variations in the isotopic composition of xenon from Renazzo indicate that a minimum of three distinct components are required to describe the situation, and this three-component system was analyzed in terms of "correlation planes." In terms of this analysis, three possible origins for the isotopic variations were considered. An $^{127}I-^{120}Xe$ formation interval for Renazzo was measured using an irradiated specimen of the meteorite. A minimum value of 66 ± 6 My is indicated. (auth)

34391 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln, ed. (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 69: 3283-7(Aug. 1, 1964).

Some data on geomagnetic activity in 1963 and early 1964 are tabulated, together with sunspot numbers for March 1964. (D.C.W.)

34392 DARKENING OF POWDERED BASALT BY SIMULATED SOLAR-WIND BOMBARDMENT. D. L. Rosenberg and G. K. Wehner (Litton Industries, Minneapolis). J. Geophys. Res., 69: 3307-8(Aug. 1, 1964).

Extended bombardment of powdered minerals and oxides was simulated on a highly accelerated scale using hydrogen and helium plasmas. With a hydrogen plasma powdered basalt developed albedo and reflection characteristics very similar to the lunar surface. Surface alteration was much less pronounced with the helium plasma. (D.C.W.)

34393 EVIDENCE FOR A COLLISION-FREE MAGNETOHYDRODYNAMIC SHOCK IN INTERPLANETARY SPACE. C. P. Sonett (Ames Research Center, Moffett Field, Calif.), D. S. Colburn, L. Davis, Jr., E. J. Smith, and P. J. Coleman, Jr. Phys. Rev. Letters, 13: 153-6 (Aug. 3, 1964).

On October 7, 1962, a rapid, apparently irreversible change in the interplanetary plasma and magnetic field was detected by Mariner II when it was 10.6×10^6 km from the earth and 36° to the left of the earth-sun line as seen by an earth observer facing the sun. The event was interpreted as a hydromagnetic shock with a structure that is vanishingly thin compared to the mean free path. (D.C.W.) (D.C.W.)

34394 MASSIVE CONDENSATIONS IN INTERSTELLAR MATTER AND STELLAR ASSOCIATIONS. Joseph F. Bird (Johns Hopkins Univ., Silver Spring, Md.). Rev. Mod Phys., 36: 717-47(July 1964).

A theory of the evolution of massive gravitational condensations is developed which supports the suggestion that stellar associations originate in the nuclear explosion of massive condensations. (D.C.W.)

34395 RADIO-EMITTING FLARE STARS. Bernard Lovell. Sci. Am., 211: No. 2, 13-19(Aug. 1964).

Experimental observations are reviewed by which radio emission by individual flare stars other than the sun was confirmed. Simultaneous optical and radio observations were used. Some implications and benefits of the finding are indicated. (D.C.W.)

34396 THE ORIGIN OF METEORITES AS SMALL BODIES. James R. Arnold (Univ. of California, San Diego, La Jolla). p.347-64 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The question of origin of meteorites is approached by Monte Carlo methods. Using a theory of Öpik [1951], the histories of a statistically significant number of cases were followed from assumed starting elements to capture by a planet or ejection from the solar system. This was repeated for a variety of possible starting conditions. The effect of major perturbations is included. It is concluded, from this evidence, and from observed cosmic ray ages, that octahedrites cannot have originated in orbits like that of Pribram (Luhy), but most probably started their lives as small bodies in orbits crossing that of Mars only. They were later perturbed by Mars into orbits crossing that of the earth. The chondrites may well originate in the same way, but lifetime considerations do not exclude a lunar origin. Neither does the observed orbit of Pribram, since cases of such final orbits occur for every starting condition considered. The manner of origin of chrondrites can, however, be decided when ten or twenty orbits become available. About 10% of all meteorites striking the earth have been as close to the sun as Mercury, whatever their origin. Hence loss of rare gases is to be expected, in a substantial number of cases. (auth)

34397 THE UREY-CRAIG GROUPS OF CHONDRITES AND THEIR STATES OF OXIDATION. Hans E. Suess (Univ. of California, San Diego, La Jolla). p.385-400 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

Precise measurements by Keil and Fredriksson of the FeO content of coexisting olivine and rhombic pyroxene in chondrites belonging to the same Urey-Craig group show surprisingly small variations. The FeO content of the silicates cannot be used as a measure for differences of the degree of oxidation of chondrites belonging to the same group. No correlation between the FeO content of the silicates and the metal content of the respective meteorite is apparent. Urey and Craig's classification of the chondrites

into two groups is more fundamental than a difference in the average iron content and the average state of oxidation. It appears that the two groups contain some unaltered material derived from two different homogeneous parent reservoirs. Some aspects of the problem of the origin of chrondrules are discussed. It is suspected that the absence of a planet in the region of the asteroids, and the constant FeO content of the silicate minerals in the Urey-Craig groups, have a common cause in the marginal vapor pressure of water at the distance of the asteroids from the sun. In this region the formation of large solid bodies may have taken place in two steps: In the first step, water and other hydrides were present as solids. Together with metal and silicate grains these solids accumulated into relatively large, perhaps lunar sized planetesimals with relatively high central temperatures. The combined heats of accumulation and of radiation from the sun led to re-evaporation of the hydrides and to the re-dissolving of these objects. Thereafter, separation of gases from metal and silicate particles occurred. In a second step, metal and silicates accumulated into objects of the composition of meteorites. On the basis of such a complex picture, the existence of the various types of meteorites and their properties can be explained by several plausible ad hoc hypotheses. (auth)

34398 PETROLOGICAL AND COMPOSITIONAL RELATIONSHIPS IN METEORITES. Harmon Craig (Univ. of California, San Diego, La Jolla). p.401-51 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The chondrites contain at least six distinct compositional groups, some of which are not distinguished in present classifications. A convenient classification which coincides with much of present usage is the division of the chondrites into Enstatite chondrites, High Iron and Low Iron chondrites, Soko-Banjites, Ornansites, and Carbonaceous chondrites. A new selection of superior analyses has been made, and compositional data and atomic abundances have been calculated for the High and Low Iron groups, the Soko-Banjites and the Ornansites. In the Carbonaceous chondrites the concentrations of MgO, SiO_2, Na_2O, and K_2O show a marked linear variation with sulphur content, when calculated on a water and carbon free basis. The available analyses of pallasites and mesosiderites have been tabulated and the compositions are compared with the chondrites. Two groups of pallasites exist which may be directly related to the High and Low Iron chondrites. The mineralogical data on olivines and pyroxenes in chondrites show that Prior's Laws apply to the chemical analyses of chondrites, but not to the chondrites themselves, when chondrites within a given group are considered. However, the chondrite groups obey the relation relative to each other, in agreement with the formulation by Craig [1953] and Yavnel [1955]. Analytical methods are not precise enough for iron to determine if the relation is obeyed within chondritic groups, because the actual variations of oxidized iron are much less than variations found even by the best present techniques. The compositions of meteoritic olivines and pyroxenes, together with the Mg–Fe distribution coefficient calculated from experimental data, indicate that the chondritic silicates crystallized at temperatures of about 1250°C, a little higher than the temperatures found for some characteristic terrestrial plutonic basic rocks. The reported presence of pigeonite and pentlandite in the Ornansites is indicative of sudden cooling from high temperatures. The pyroxenes of the High and Low Iron groups and Soko-Banjites probably crystallized directly as orthorhombic pyroxene, or as protobronzite, depending on the pressure. A new sub-solidus phase diagram for the pyroxenes is proposed to explain the lack of indication of crystallization in the monoclinic form in the rhombic pyroxenes of these three groups. (auth)

34399 ISOTOPE ANOMALIES IN XENON FROM METEORITES AND XENON FROM NATURAL GASES. W. B. Clarke and H. G. Thode (McMaster Univ., Hamilton, Ont.). p.471-87 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

A sensitive mass spectrometer has been used to measure isotope abundances and amounts of xenon gas extracted from four stone meteorites and four samples of helium-bearing natural gases. Isotope abundances and amounts of argon in the natural gas samples were also measured. Kuroda's hypothesis, that atmospheric xenon contains a portion of fission-product xenon from spontaneous fission of an extinct transuranium element (such as ^{244}Pu) was adopted. Abnormally high yields of ^{131}Xe and ^{132}Xe (relative to ^{136}Xe) in the fission-product component of xenon in the atmosphere are explained by analogy with the results of experiments on the diffusion of fission-product xenon from neutron irradiated uranium oxide powders. In these experiments marked enrichments of ^{131}Xe and ^{132}Xe are observed for low temperature (<500°C) release of fission-product xenon. Only about 1 per cent of the available xenon is released below 500°C from uranium oxide powders. This explanation of the ^{131}Xe and ^{132}Xe discrepancies in fission-product xenon in the atmosphere therefore requires that the earth has been outgassed only to a small extent. Xenon from natural gas was observed to contain a component of fission-product xenon (relative to xenon from the atmosphere). Good agreement was found for the He^4/Xe (fission) and ^{40}A (radiogenic)/Xe (fission) ratios in the natural gas samples and the ratios calculated for a rock reservoir containing 3% potassium, 3 ppm uranium and 12 ppm thorium. The fission-product component of xenon in natural gas exhibits high yields at ^{131}Xe and ^{132}Xe (relative to ^{136}Xe) when compared to relative xenon yields from spontaneous fission of ^{238}U. An explanation is given for the ^{131}Xe and ^{132}Xe yield discrepancies. (auth)

34400 STABLE ISOTOPE STUDIES OF SOME HEAVY ELEMENTS IN METEORITES. V. Rama Murthy (Univ. of California, San Diego, La Jolla). p.488-515 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The isotopic abundance studies of eleven heavy elements in meteorites covering the mass range 92-208 are described. Studies concerned with extinct radioactivity seem to indicate that solid bodies formed in the solar system within less than 100 million yrs after the "cessation of nucleosynthesis" for the solar system. Whether this "cessation" refers to the isolation of the solar nebula from the galactic nucleosynthesis, or to nucleosynthesis in the solar nebula, or to contributions of nucleosynthetic material shortly prior to the formation of the solar nebula cannot be unequivocally decided by the present isotopic evidence. The role played by the isotopic studies, particularly of xenon and the rare earth elements samarium, europium and gadolinium, in meteorites, to help tie in the nuclear history with the physico-chemical history of the early solar system and meteorites is discussed. The general isotopic anomalies of Xe in meteorites are yet unmatched in other heavy elements because the result on Ba need confirmation and those on Mo appear doubtful. Many other heavy elements covering large mass ranges in their isotopes do not seem to exhibit any anomalies. The presence of radiogenic lead in several iron meteorites is

interpreted as the result of collisional events in which radiogenic lead from high U/Pb systems (silicate bodies) was transferred to these irons, in relatively recent pre-terrestrial events. (auth)

34401 ON THE ABUNDANCES OF URANIUM AND THORIUM IN SOLAR SYSTEM MATERIAL. F. Hoyle (Cambridge Univ., Eng.) and William A. Fowler. p.516-29 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The theoretically calculated abundances of U and Th relative to Si for solar system materials are reviewed, with arguments based primarily of nuclear theory and only in part on experimental determinations from meteorites. It is concluded that the primordial U concentration for the inner solar system should not be less than 0.014 ppm, and the Th concentration not less than 0.25 ppm. If no U-Th loss occurred, the present day concentrations are therefore 0.054 ppm for U and 0.20 ppm for Th, the latter values being greater by a factor of ≈4 than the measured values for Enstatite chondrites, and by ≈2 for Carbonaceous chondrites. (L.B.S.)

34402 CHEMICAL COMPOUNDS ON COMETS. Jay A. Glasel (Columbia Univ., New York). p.530-7 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

The problem of the chemical nature of comets is reviewed. Emphasis is laid upon laboratory experiments which are connected with cometary phenomena. The results of these experiments are discussed, and some possible further work is suggested. The conclusion is drawn that there are very large differences between the results of observations on experimental models and theoretical work leading to these models. (auth)

34403 DYNAMIC STUDIES WITH A GAMMA-RAY SCINTILLATION CAMERA. G. Myers (Ohio State Univ., Columbus). Vienna, International Atomic Energy Agency, 1964, Preprint SM-51/98, 13p. (CONF-453-10)

From IAEA Symposium on Medical Radioisotope Scanning, Athens, Apr. 1964.

A scintillation camera was used to study dynamic physiological and pharmacological processes in vivo. The 0.6 × 20-cm NaI crystal is viewed by 19 multiplier phototubes. Light flashes generated in this plate by gamma rays are caused electronically to appear as small coruscations in the same relative positions on an oscilloscope screen. A Polaroid camera focused on this screen gradually forms a picture, the spatial densities of which represent the spatial distribution of gamma rays projected from the biological object into the collimating system. Either a 5-mm diameter "pinhole" or a 771-hole multi-aperture lead collimator is used to view an area of ~16-cm maximal diameter. Pictures can be made in fast sequence to record rapid changes in distribution of gamma isotopes. A maximum rate of three pictures each minute was achieved with 10-sec Polaroid roll film. After ^{131}I-iodide was injected intravenously into a rat-fed Purina Labchow, a series of pictures, taken during the first two minutes of six successive five-minute intervals, revealed rapid disappearance of the radioiodine initially distributed throughout the whole body and concentration in the stomach region within 30 min. Most of the radioactivity remained localized there during the remaining seven hours of the experiment, at which time only a modicum had accumulated in the thyroid. Similarly, after subcutaneous injection of ^{131}I-orthoiodohippurate into a rat's supraclavicular region, the camera revealed migration into the kidneys within three minutes, into the bladder in five minutes, and complete clearance into the bladder in 90 minutes. (auth)

Atomic Physics

34404 (COO-1277-5) ANGULAR AND ENERGY DISTRIBUTION OF ELECTRONS FROM GASES IONIZED BY PROTON IMPACT. Technical Status Report No. 5, April 1, 1964 to July 31, 1964. M. Eugene Rudd and Carl L. Bailey (Concordia Coll., Moorhead, Minn.). Aug. 1, 1964. Contract AT(11-1)-1277. 8p.

The apparatus for and present status of experiments to determine the cross sections for proton-impact ionization of various gases over a wide range of proton energies are described. (R.E.U.)

34405 (NASA-CR-87) PLANETARY PHYSICS. V. AN EXPANSION METHOD FOR CALCULATING ATOMIC PROPERTIES. II. TRANSITION PROBABILITIES. M. Cohen and A. Dalgarno (Geophysics Corp. of America, Bedford, Mass.). Aug. 1964. For National Aeronautics and Space Administration, Washington, D. C. Contract NASw-840. 36p.

An earlier expression for the expectation value of a single-electron operator, which is stationary with respect to first-order variations of the state wave function, was generalized to the case of an off-diagonal matrix element connecting two different states. Explicit calculations are carried out of the probabilities of dipole transitions between configurations $1s^a\ 2s^b\ 2p^c$ and $1s^a\ 2s^{b-1}\ 2p^{c+1}$ for all members of the isoelectronic sequences from helium to neon, and the importance of taking into account the mixing of degenerate configurations is demonstrated. The accuracy is at least comparable to that of the Hartree-Fock approximation and in cases where degeneracy is important it is much superior. (auth)

34406 (TID-20877) THE IONIZATION OF ALKALI IONS BY ELECTRON IMPACT. Quarterly Technical Progress Report No. 6, March 1–May 31, 1964. J. W. Hooper, E. W. McDaniel, and W. C. Lineberger (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). June 1, 1964. Contract AT(40-1)-3027. 7p.

A research program is being conducted to measure the cross section for ionization of Li^+ ions by electron impact at electron energies from 75.6 to 1000 ev. Tests were made on the Li^+ primary beam and on the electron gun, and the difficulties encountered are discussed. (D.L.C.)

34407 (UCRL-11071) MOLECULAR SCATTERING AT THERMAL ENERGIES (thesis). Philip Russell Brooks (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1964. Contract W-7405-eng-48. 129p.

In order to study molecular beams the Kingdon cage is developed and its characteristics as a molecular beam detector are investigated. This detector consists of a diode cage in which positive ions formed by electron bombardment of the beam partially neutralize the effect of space charge. Beams of a variety of materials are detected and total collision cross sections for beams of Xe scattered by Xe and CH_3I and for beams of CH_3I, i-C_3H_7I and n-C_3H_7I each scattered by CH_3I, i-C_3H_7I, and n-C_3H_7I. The results indicate, as suggested by theory, that the net dipole-dipole interaction is stronger for symmetric rotor molecules than for asymmetric top molecules. Total collision cross sections for potassium scattered from neon, argon, and CH_3I are also measured, to provide a comparison with previous investigations, and reasonable agreement is obtained. An analysis is given of the effect of the

apparatus resolution in the measurement of total cross sections. This shows the importance of considering the resolution in the center of mass system, and provides a procedure for estimating the error due to insufficient resolution. Several previous studies in which the resolution error is appreciable are discussed. The effect is also investigated experimentally by measuring the cross section for potassium scattered from neon, argon, and CH_3I at different angular resolutions. (auth)

34408 (UCRL-11249) COLLISIONAL EXCITATION AND LORENTZ IONIZATION OF 10-Mev HYDROGEN ATOMS (thesis). Klaus H. Berkner (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 13, 1964. Contract W-7405-eng-48. 99p.

Ten-Mev hydrogen atoms with a population distribution covering all excited states are produced by collisional dissociation of 20-Mev H_2^+ ions. The populations of the higher excited levels are removed by Lorentz ionization, and the levels are then repopulated by collisional excitation of the atoms in molecular or weakly ionized hydrogen targets. The populations of the levels n = 6 to 9 are determined by a second Lorentz ionization. The threshold fields for Lorentz ionization of the levels n = 5 to 9 are found to be in good agreement with theoretical calculations for electric-field ionization. The populations of the levels n = 6 to 9 of atomic hydrogen produced by collisional dissociation of H_2^+ on H_2 are found to be $N_n/N_1 \approx 3/n^3$, a distribution that is consistent with theoretical estimates. For hydrogen plasma targets, excitation cross sections were measured for collisions with electrons and ions. Cross sections for transitions from the levels n = 5, 6 to the levels n′ = 6, 7, 8, 9 and upper limits for the transitions n = 1 or 4 to n′ = 6 or 7 were obtained. These are compared with calculations in the first Born, Bethe, and impact-parameter approximations; good agreement is found for all transitions, although those with $\Delta n = 2$ are somewhat larger than calculated. (auth)

34409 MEASUREMENT OF CHARGE EXCHANGE CROSS SECTIONS OF MERCURY AND XENON IONS IN AIR. F. Brouillard and J. M. Delfosse. Ann. Soc. Sci. Bruxelles, Ser. I, 78: 149-56(June 15, 1964). (In French)

A double-focusing mass spectrograph was used to measure several charge-exchange cross sections for multiply-charged ions of Xe and Hg in air in the energy range from 10 to 80 kev. The loss of one charge is the most probable event, its cross section being of the order of 10^{-15} cm^2 (larger for Xe than Hg) and generally increasing with increasing initial charge. Further, the cross sections seem to be strongly dependent on the excitation state of the ions. (auth)

34410 THE X-RAY L-EMISSION BANDS OF 46 Pd–52 Te. Erik Noreland and Boerje Ekstig (Uppsala Univ.). Arkiv Fysik, 26: 161-84(1964).

The x-ray L-emission valence band spectra in the elements Pb through Te were experimentally studied. The measurements were performed with a bent crystal spectrometer with a proportional counter as detector. The influences on the registered spectra due to the nonlinearity of the intensity scale, the instrumental resolving power, the background radiation, the target self-absorption and the satellites are discussed. With the exception of the L_I spectra of Pd, Ag, and Cd, which were not detected, the obtained spectra have been published. In these curves the shape of the emission bands is given, except for the unresolved L_{II} and L_{III} spectra of Ag, Cd, and Sb. (auth)

34411 THE X-RAY $L\gamma_4$ EMISSION BAND OF 48 Cd. Igor Ia. Nikiforov, Erik Noreland, and Boerje Ekstig (Uppsala Univ.). Arkiv Fysik, 26: 319-22(1964).

The $L\gamma_4$ emission band of Cd was investigated using a bent-crystal vacuum spectrometer and a proportional counter. A two-peak shape of the band was determined. The Z-dependence of the $L\gamma_4$ intensity and the $L\gamma_{2,3}$ intensity shows the relative quantity of the valence p electrons in the solid state for the elements from Cd to Te. (auth)

34412 A DISCUSSION OF THE L-ABSORPTION SPECTRA AND THE L-EMISSION BANDS OF 46 Pd-52 Te. Erik Noreland (Uppsala Univ.). Arkiv Fysik, 26: 341-59 (1964).

Recent registrations of the L-emission bands of Pd to Te and the previously recorded L-absorption spectra were corrected for the smearing due to the spectral window and the inner level. The corrected absorption spectra and emission bands are compiled. The values of the high energy edge of the emission bands and the values of the absorption edges are compared to the corresponding binding energies obtained with the photoelectron method. The results indicate that the spin-orbit coupling is not broken down in the 4d band of Pd. The shapes and the widths of the 5s and 5p density of states functions of the elements In through Te are included. The number of electrons in the filled parts of the 5s and 5p bands is estimated. From the width of the emission band edges and the absorption edges, L_I, L_{II} and L_{III} level widths have been determined. The relation of these widths to the L_I $L_{II,III}$ $M_{IV,V}$ Coster-Kronig transition rates is discussed. (auth)

34413 COHESIVE ENERGY OF SOLID NEON. Jan Linderberg and Fred W. Bystrand. Arkiv Fysik, 26: 383-95(1964).

The contributions to the cohesive energy of solid neon were evaluated. The Hartree-Fock energy was calculated in the tight-binding approximation, and the correlation energy was obtained from many-electron theory. The zero-point energy was taken from other sources. The cohesive energy so obtained is in satisfactory agreement with experiment. (D.C.W.)

34414 EXTENSION OF THE PHOTOELECTRON METHOD TO ELEMENTS OF LOW ATOMIC NUMBER. Stig Hagstroem and Sven-Erik Karlsson (Uppsala Univ.). Arkiv Fysik, 26: 451-77(1964).

The photoelectron method for precision determinations of atomic energy levels was extended to light elements. Photoelectron determinations of the K energy levels are reported for the elements Z = 5 to 24, except the rare gases Ne and Ar. By combination of the photoelectron data with x-ray emission data a complete set of energies of the inner levels was obtained. The possible charging effect when using an insulator as a backing material or as a converter was investigated. It was found that the x rays act as a discharger, and no shift of the photoelectron lines could be observed. For the calibration, weighted mean values of the momentum of the ThB F- and I-lines were calculated in terms of the 1955 and 1963 sets of atomic constants. (auth)

34415 THE DISTRIBUTION FUNCTIONS OF A SYSTEM OF CHARGED PARTICLES IN THERMODYNAMIC EQUILIBRIUM. Rolf Dobbertin. Compt. Rend., 258: 5587-90(June 8, 1964). (In French)

The distribution functions of density and of correlation for a system of particles in Coulomb interaction in thermodynamic equilibrium in a finite volume were calculated. The calculations were applied to a neutral and binary plasma. (tr-auth)

34416 ENERGY LOSSES EXPERIENCED BY FAST RARE GAS IONS (80 Kev) AFTER COLLISIONS WITH RARE GAS ATOMS (ARGON, KRYPTON, XENON). Michel Barat, Jacques Baudon, and Albert Septier (Faculte des Sciences, Orsay, France). Compt. Rend., 258: 5603-6 (June 8, 1964). (In French)

Experimental results pertaining to discrete energy losses undergone by He^+, Ne^+, and Ar^+ ions of energy 80 kev in targets of Ar, Kr, and Xe are presented, for a scattering angle of zero. (tr-auth)

34417 ON THE INVESTIGATION OF "Z" DEPENDENCE OF RAYLEIGH SCATTERING OF GAMMA RAYS. S. Anand, M. Singh, and B. S. Sood (Panjab Univ., Chandigarh, India). Current Sci. (India), 33: 333-4(June 5, 1964).

Gamma radiation scattering at 280 kev through angles greater than 75° where coherent scattering can be easily separated from the incoherent scattering energetically was studied. The variation of the index to the power of Z with momentum transfer was compared with the available theoretical calculations. The results clearly contradict the Z^3 dependence as previously predicted by the non-relativistic form factor calculations. The experimental curve obtained may be used along with existing experimental data on cross sections and refined calculations for scattering from Hg to make a reliable estimate of Rayleigh cross section for any element. (P.C.H.)

34418 INTERACTION ENERGIES, CHARGE EXCHANGE CROSS SECTIONS, AND DIFFUSION CROSS SECTIONS FOR $N^+ - N$ AND $O^+ - O$ COLLISIONS. Hans Knof, E. A. Mason, and J. T. Vanderslice (Univ. of Maryland, College Park). J. Chem. Phys., 40: 3548-53(June 15, 1964).

Potential energy curves for the lower electronic states of the N_2^+ and O_2^+ molecules were obtained from a semiempirical valence bond method that makes use of available spectroscopic data. From these curves the probability of charge exchange was calculated, and from this the charge-exchange and diffusion cross sections. The cross sections for the $O^+ - O$ collisions are in good agreement with the experimental values of Stebbings, but differ by about a factor of 3 from earlier theoretical estimates. Some consequences of this are discussed. (auth)

34419 ATOMIC EMISSION OF THE HELIUM AFTERGLOW. Franklin E. Niles and W. W. Robertson (Univ. of Texas, Austin). J. Chem. Phys., 40: 3568-71(June 15, 1964).

The spectral emission from a d-c pulsed helium discharge for pressures from 5 to 20 torr was investigated during the early afterglow using interference filters with gated photomultiplier. The radiation transmitted by the filters consists generally of both atomic lines and molecular bands and after the termination of the active discharge shows characteristically an initial rapid decrease in intensity followed by a much slower rate. The rapid decrease is due to the atomic radiation, the slower to molecular. By subtracting the molecular emission from the total emission transmitted through an interference filter, the atomic emission was obtained. From the decay curves of the atomic emission, which is the result of collisional-radiative recombination of He^+, and the known diffusion loss of He^+, the rate of conversion of He^+ into He_2^+ was found to be 109 ± 6 sec^{-1} $torr^{-2}$. (auth)

34420 ATOMIC-BEAM SCATTERING FROM EPITAXIALLY GROWN GOLD FILMS. Joe N. Smith, Jr. and H. Saltsburg (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Chem. Phys., 40: 3585-91 (June 15, 1964).

The spatial distribution of beams of He and Ar scattered by gold-target films was examined mass spectrometrically during and after the formation of these films by evaporative deposition. By controlling the target temperature during the deposition of the metal, varying degrees of crystallographic orientation and surface smoothness were obtained. The metallic deposition rate was maintained high as compared with the impingement rate of background gas particles, resulting in approximate clean-surface conditions during deposition. For rough polycrystalline films, only cosine scattering of He and Ar was observed. For smooth, well-oriented films, specular scattering of He was observed during deposition. In this latter case, a gradual time-dependent dispersion in He scattering was seen after deposition and is shown to result from the formation of adsorbed gas layers. For Ar scattered from a smooth gold film during deposition, a broad directed beam, displaced from the specular angle, is obtained, and very little dispersion occurs after deposition. The latter result is interpreted as being due to the greater interaction between Ar and gold, compared with that between He and gold, which masks the effects of adsorbed gases upon Ar scattering. (auth)

34421 PHOTOIONIZATION AND ABSORPTION CROSS SECTIONS OF H_2 AND D_2 IN THE VACUUM ULTRAVIOLET REGION. G. R. Cook and P. H. Metzger (Aerospace Corp., El Segundo, Calif.). J. Opt. Soc. Am., 54: 568-72(Aug. 1964).

The absorption and photoionization cross sections of D_2 and H_2 were measured in the region from 580 to 1000 Å with a resolution of 0.5 Å. Simultaneous measurements of ion current and absolute photon flux were made in a chamber 40.6 cm long with a parallel-plate ion collector and a platinum photocathode or a sodium salicylate-coated photomultiplier tube. The absolute yield of the photocathode was measured by calibrating the chamber with Ar, Kr, and Xe atoms. (auth)

34422 MOLECULAR SCHRÖDINGER EQUATION. I. ONE-ELECTRON SOLUTIONS. Harold Conroy (Mellon Inst., Pittsburgh). J. Chem. Phys., 41: 1327-31(Sept. 1, 1964).

A general form for the wavefunction of a single bound electron moving in the field of arbitrary fixed nuclei is proposed. The use of this wavefunction in the molecular Schroedinger equation results in the exact cancellation of singularities due to the electron-nuclear attractive potential. Illustrations of its application to the first few states of the hydrogen molecule-ion (H_2^+) as well as information about accuracy and convergence rate are presented. (auth)

34423 MOLECULAR SCHRÖDINGER EQUATION. II. MONTE CARLO EVALUATION OF INTEGRALS. Harold Conroy (Mellon Inst., Pittsburgh). J. Chem. Phys., 41: 1331-5(Sept. 1, 1964).

A novel method for the evaluation of many-centered, polyelectronic integral matrices of the type that occur in quantum chemical problems is proposed. (auth)

34424 MOLECULAR SCHRÖDINGER EQUATION. III. CALCULATION OF GROUND-STATE ENERGIES BY EXTRAPOLATION. Harold Conroy (Mellon Inst., Pittsburgh). J. Chem. Phys., 41: 1336-40(Sept. 1, 1964).

The problem of optimization of the parameters in a trial wavefunction can be approached through the minimization of the energy variance function, a procedure that offers certain important advantages over the customary one where the energy function itself is minimized. The use of an energy variance calculation further permits extrapolation to a more accurate approximation to the true energy than can

be attained solely from a knowledge of the ordinary upper and lower bounds. Specific computational procedures are discussed. (auth)

34425 MOLECULAR SCHRÖDINGER EQUATION. IV. RESULTS FOR ONE- AND TWO-ELECTRON SYSTEMS. Harold Conroy (Mellon Inst., Pittsburgh). J. Chem. Phys., 41: 1341-51(Sept. 1, 1964).

A general form, based upon configuration interactions, but including correlation to hasten convergence, is proposed for two-electron wavefunctions. The advantages of the correlation treatment developed include the ability to remove the singularity in the interelectronic potential from the Schroedinger equation. The results of sample calculations for hydride ion and helium are presented. In addition, the results obtained in the application of the one- and two-electron treatments to the systems HeH^{2+}, HeH^{+}, and linear and triangular H_3^{2+} and H_3^{+} are discussed in detail, the accurate potential energy surfaces for the latter molecules having been elucidated. (auth)

34426 TIME-DEPENDENT PERTURBATION THEORY OF THE HARTREE-FOCK WAVEFUNCTION OF ATOMIC AND MOLECULAR SYSTEMS. Howard B. Levine (North American Aviation Science Center, Thousand Oaks, Calif.). and Howard S. Taylor. J. Chem. Phys., 41: 1367-9(Sept. 1, 1964).

It is shown that time-dependent perturbation theory can be applied exactly to the Hartree–Fock model of closed-shell atoms and molecules by means of integration over the excited-state continuum. The frequency-dependent polarizability of the Be atom is calculated as an example. (auth)

34427 GAUSSIAN CORRELATION FUNCTIONS: TWO-ELECTRON SYSTEMS. William A. Lester, Jr. (Catholic Univ. of America, Washington, D. C. and National Bureau of Standards, Washington, D. C.) and Morris Krauss. J. Chem. Phys., 41: 1407-13(Sept. 1, 1964).

The correlated molecular orbital method was applied to the He isoelectronic sequence and H_2 using a Gaussian basis set to explore the possible use of Gaussian basis function in wave functions containing explicit electron correlation for larger systems. The wave functions were analyzed in terms of the change in the electron-pair distribution and a comparison of the Coulomb holes was made for the atomic cases. The dependence of the correlation improvement on the accuracy of the orbital functions is discussed. General formulas for Gaussian correlation integrals also are included. (auth)

34428 ATOMIC SHIELDING PARAMETERS. Gerald Burns (International Business Machines Corp., Zurich). J. Chem. Phys., 41: 1521-2(Sept. 1, 1964).

A new set of rules is given for obtaining n^*, effective quantum number, and S, the screening constant, for much better agreement with the wave functions. Two forms of wave functions were considered, the hydrogenic form and the nodeless exponential form. S was obtained by directly comparing the simple analytic wave functions to Hartree-Fock wave functions that were previously calculated. The recipes given are designed to reproduce the outer parts of the self-consistent wave function. (P.C.H.)

34429 SCATTERING OF ELECTRONS ON LITHIUM ATOMS. E. M. Karule and R. K. Peterkop. Latvijas PSR Zinatnu Akad. Vestis, No. 1, 53-8(1964). (In Russian)

Effective cross sections for elastic scattering and for excitation of $1s^2$ 2p state of lithium atoms by electrons are calculated by means of the Born approximation. Cross sections of diffusion and viscosity are determined. The dependence of results on the choice of the atomic wave functions is investigated. (auth)

34430 EXCITATION OF NEON ATOMS BY ELECTRONS. V. Ya. Veldre, A. V. Lyash, and L. L. Rabik (Inst. of Physics, Academy of Sciences, Latvian SSR). Latvijas PSR Zinatnu Akad. Vestis, No. 2, 3-7(1964). (In Russian)

The problem of the excitation of neon atoms by electron impact was investigated. The total cross sections of the excitation of neon atoms by electrons were given for the transitions 2p–3s, 2p–4s, 3s–4s, and 3p–4s. The total cross sections of neon atom excitation were evaluated in the Born approximation. The dependence of the total cross sections of neon atom excitation upon the selection of wave functions was shown. (auth)

34431 MEASUREMENT OF THE EFFECTIVE CROSS SECTION FOR K IONIZATION THROUGH ELECTRON AND POSITRON IMPACT. H. Hansen, H. Weigmann, and A. Flammersfeld (Universität, Göttingen, Ger.). Nucl. Phys., 58: 241-53(Sept. 1964). (In German)

The absolute cross sections for K ionization in thin foils of Zr, Sn, W, and Pb by electron and positron impact were measured using a β spectrometer and a NaI(Tl) scintillation crystal. The electron and positron energies were varied from 240 to 1440 kev. In all cases the values obtained are much larger than those given by the non-relativistic theory. No systematic difference was found between the values measured with electrons and positrons, respectively. According to the measurements the exponent of Z in the ionization cross section varies from $\nu = 2.60 \pm 0.20$ to 2.00 ± 0.30 for electron energies between 240 and 1440 kev. (auth)

34432 MATRIX ELEMENTS FOR CHARGE-EXCHANGE PROCESSES. R. M. May (Univ. of Sydney). Phys. Letters, 11: 26-7(July 1, 1964).

The inclusion of proton-proton interactions in the perturbation matrix elements for charge-exchange of the type $H^+ + H(1s) \rightarrow H(nlm) + H^+$ is discussed. It is proved that in the limit $m/M \rightarrow 0$, the import parameter calculation, in which the incident proton trajectory is taken as a straight line and only the e-p interaction is included, is correct. The complete hamiltonian for the 3-body system is given, and cross sections are calculated for proton energies of 0.2 to 60 kev. (R.E.U.)

34433 IONIZATION OF A GAS UNDER THE EFFECT OF IONS OF 200 TO 1200 Kev. J.-C. Abbe and J.-P. Adloff (Centre de Recherches Nucleaires, Strasbourg). Phys. Letters, 11: 28-9(July 1, 1964). (In French)

Molecular fragmentation was studied for ethylene and ethane for 70-ev electrons and 200- to 1200-kev protons, and for ethylene for hydrogen, deuterium, helium, nitrogen, neon, and argon ions at 200 and 400 kev. Mass-to-charge ratios are given for the fragments. (R.E.U.)

34434 FORMATION OF HIGHLY EXCITED NEUTRAL ATOMS BY CHARGE-EXCHANGE. R. M. May (Univ. of Sydney). Phys. Letters, 11: 33-4(July 1, 1964).

Charge-exchange reactions of the type $H^+ + H(n_1 l_1 m_1) \rightarrow H(n_2 l_2 m_2) + H^+$ are considered where n, l, and m are the usual H-atom quantum numbers. Cross sections for formation of final excited states are calculated in Born approximation. (R.E.U.)

34435 CALCULATED ENERGIES OF 2p-1s μ-MESONIC X-RAYS. P. Palit (Carnegie Inst. of Tech., Pittsburgh). Phys. Letters, 11: 82-3(July 1, 1964).

A Fermi two-parameter model for the nuclear charge distribution is used to calculate some properties of μ-mesic atoms. The radial Dirac equations for the μ-meson

in the Coulomb potential due to this charge distribution were solved for the 2p-1s transition energy. (R.E.U.)

34436 VIBRATIONAL AND CENTRIFUGAL EFFECTS OF THE MAGNETIC SUSCEPTIBILITY AND ROTATIONAL MAGNETIC MOMENT OF THE HYDROGEN MOLECULE. Sunney I. Chan (California Inst. of Tech., Pasadena), Dennis Ikenberry, and T. P. Das. Phys. Rev., 135: A960-8 (Aug. 17, 1964).

The effects of nuclear motion on the magnetic susceptibility and rotational magnetic moments of H_2, HD, and D_2 are considered. The magnetic susceptibility and the rotational magnetic moment were evaluated as a function of the internuclear distance by a variational procedure using the accurate wave functions of Kolos and Roothaan. A careful vibrational averaging was performed to obtain these magnetic properties for H_2, HD, and D_2 in a number of vibrational-rotational states. A critical test of these calculations is provided by a comparison of the calculated $\langle\mu_R^e\rangle_{v,J}$'s (electronic contribution to the rotational magnetic moment) with experiment. While the one-parameter variational calculations only account for 70% of the experimental $\langle\mu_R^e\rangle_{v,J}$'s, ratios of the calculated $\langle\mu_R^e\rangle_{v,J}$'s between the three isotopic molecules in their respective vibrational-rotational states are in remarkable agreement with the experimental ratios (within 0.3%). A similar vibrational averaging of $\mu_R^e(R)$ obtained by Espe using a four-parameter variational calculation based upon the zero-order wave function of Newell indicates that while the theoretical $\langle\mu_R^e\rangle_{v,J}$'s are now within 10% of the experimental values, the ratios of the $\langle\mu_R^e\rangle_{v,J}$'s are not in as good agreement with experiment. The implication of these results on the molecular-beam method of obtaining molecular dipole moments from isotopic variations of the rotational magnetic moment is discussed. (auth)

34437 TOTAL ENERGIES FROM NUMERICAL SELF-CONSISTENT FIELD CALCULATIONS. E. C. Snow, J. M. Canfield, and J. T. Waber (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 135: A969-73(Aug. 17, 1964). (LADC-6163)

Total energies computed by using a Hartree, a Hartree-Fock-Slater, and a relativistic Dirac-Slater numerical self-consistent field calculation for the normal ground states of all the elements are reported. These results are discussed and compared with those from two Hartree-Fock analytical wave functions and from a nonrelativistic Thomas-Fermi approximation. The methods of calculating total energies are also presented. (auth)

34438 MAGNETIC SUSCEPTIBILITY OF $2\,^3S_1$ STATE OF HELIUM AND SOME LIKE IONS. John T. McMullan (Cornell Aeronautical Lab., Inc., Buffalo) and R. P. Hurst. Phys. Rev., 135: A973-7(Aug. 17, 1964).

The magnetic susceptibility of the $2\,^3S_1$ state of helium and some like ions is computed using a thirty-five term wave function of the type originally proposed by Hylleraas and Undheim. It is found that it is possible to obtain highly accurate values for the magnetic susceptibility using this wave function if the parameters are accurately determined. An argument is given which suggests that the magnetic susceptibility obtained is accurate to at least five significant figures. (auth)

34439 INFLUENCE OF ATOMIC BINDING ON THE RECOIL DISTRIBUTION IN ELECTRON-FIELD PAIR PRODUCTION. Charles Kaufman (Pennsylvania State Univ., University Park). Phys. Rev., 135: A985-7(Aug. 17, 1964).

The recoil-momentum distribution in high-energy triplet production in hydrogen, taking into account the initial atomic binding of the electron, is calculated. The method of Wheeler and Lamb is used, with the final atomic state specified to be an outgoing electron (Coulomb wave). Explicit recoil distributions for various photon energies from 84 to 2000 mc^2 are obtained, and a binding correction to the total triplet cross section of Borsellino is calculated. (auth)

34440 VIBRATIONAL EXCITATION OF N_2, CO, AND H_2 BY ELECTRON IMPACT. G. J. Schulz (Westinghouse Electric Corp., Pittsburgh). Phys. Rev., 135: A988-94 (Aug. 17, 1964).

The cross section for vibrational excitation of N_2, CO, and H_2 by electron impact is measured using a double electrostatic analyzer. Electrons are examined after scattering from the molecules at an angle of 72 deg. Both N_2 and CO exhibit a small vibrational cross section to the first state below 1.7 and 1.0 ev, respectively, which is attributed to direct excitation by electron impact. Above these energies, many vibrational states are excited and the cross section becomes large; it is postulated that the excitation proceeds via a compound state of N_2 and CO. The peak of the cross section occurs at 2.3 ev in N_2 and 1.75 ev in CO. In hydrogen, the cross section to the first vibrational state predominates; the cross section to the second vibrational state of H_2 is about 14% of the first state, at an energy of 3.4 ev. (auth)

34441 RANGES OF LOW-ENERGY GALLIUM ATOMS IN COPPER AND ZINC. Norbert T. Porile (Brookhaven National Lab., Upton, N. Y. and McGill Univ., Montreal). Phys. Rev., 135: A1115-18(Aug. 17, 1964). (BNL-7930)

The ranges of 0.07–1.0-Mev gallium atoms in copper and zinc were measured by means of thick-target recoil experiments. Monoenergetic gallium recoils were generated by the $^{64}Zn(p,\gamma)$, $^{64}Zn(d,\gamma)$, and $^{63}Cu(\alpha,\gamma)$ reactions. The results can be expressed by an empirical range-energy relation of the form $R(\mu g/cm^2) = 0.193\ E(kev)$ for $E \leq 1.0$ Mev. The results of the present experiment and of other studies in this mass range are compared with the theoretical range-energy relation of Lindhard, Scharff, and Schiott, and very good agreement is found for values of the reduced energy ranging from 0.4 to 5.0. The low-energy results are also compared with the calculation of Oen, Holmes, and Robinson. In its simplest form, this calculation predicts range values that are significantly larger than the experimental results. (auth)

34442 QUADRUPOLE ANTISHIELDING FACTORS FOR RARE-EARTH AND SOME OTHER HEAVY IONS. R. E. Watson (Bell Telephone Labs., Murray Hill, N. J.) and A. J. Freeman. Phys. Rev., 135: A1209-12(Aug. 31, 1964).

Sternheimer quadrupole antishielding factors (γ_∞) are reported for several rare-earth ions and for several ions isoelectronic with I^- and Br^-. Radial excitations were obtained using the self-consistent-field unrestricted Hartree-Fock method (orbitally polarized H-F method) described previously. Comparisons with perturbation-theory estimates of Sternheimer are presented. It is concluded that a roughly constant value of $\gamma_\infty \approx -80$ is appropriate for the trivalent rare-earth ions. The relation to experiment of theoretical estimates of γ_∞ for positive and negative ions is discussed. (auth)

34443 ATOMIC ABSORPTION CROSS SECTION OF SODIUM VAPOR BETWEEN 2400 AND 1000 Å. R. D. Hudson (Aerospace Corp., El Segundo, Calif.). Phys. Rev., 135: A1212-17(Aug. 31, 1964).

The continuous atomic absorption cross section of sodium vapor was measured using photoelectric techniques

from the $3s^2S \rightarrow np^2P^0$ series limit at 2412.6 Å, down to 1000 Å. The bandwidth of the monochromator was 1 Å, and values of the cross section were obtained at about 2-Å intervals. The best value for the atomic absorption cross section at the series limit was 0.130 ± 0.018 Mb. A zero minimum was observed at 1950 Å, in agreement with theoretical predictions but conflicting with previous experimental results. The reasons for this conflict are discussed, and a description is given of the experimental procedures adopted. (auth)

34444 QUANTUM-MECHANICAL CALCULATIONS FOR THE ELECTRIC FIELD GRADIENTS AND OTHER ELECTRONIC PROPERTIES OF LITHIUM HYDRIDE: THE USE OF MIXED ORBITAL SETS. J. C. Browne and F. A. Matsen (Univ. of Texas, Austin). Phys. Rev., 135: A1227-32(Aug. 31, 1964).

For quantum-mechanical calculations on diatomic molecules the use of mixed orbital sets composed of both Slater-type orbitals and elliptic orbitals is proposed. The Slater-type orbitals provide a good representation of the essentially spherical charge distributions near atoms in molecules and the elliptic orbitals provide good electronic distributions for the delocalized valence electrons. Calculations were performed with up to 28 terms of the mixed orbital set on the lithium hydride molecule and the most accurate wave function yet published was obtained. The values for the several molecular parameters are as follows: (the experimental values are given in parenthesis) $-E = 8.0561$ a.u. (8.0703); $R_e = 3.046$ a.u. (3.013); $\omega_e = 1438$ cm^{-1} (1406); $\omega_e\chi_e = 86$ cm^{-1} (23); $\mu_0 = 5.93$ (5.88); $\mu_1 = 6.00$ (5.99); $\mu_2 = 6.05$ (6.10); $[\mu_e/(R_e\partial\mu/\partial R|_{R_e})] = 1.74$ (1.8 ± 0.3). As is usually the case, the results are superior to self-consistent field calculations. The electric field gradients at both nuclei were calculated. The quadrupole coupling for D in LiD was obtained using q_H and yielding $eq_DQ_D/h =$ 34.2 kc (33 ± 1 kc). When q_{Li} is combined with the experimental quadrupole coupling constant $Q_{Li} = -4.3 \times 10^{-26}$ cm^2. This is considerably larger than the shell-model estimate and supports the proposal that for odd-proton nuclei nucleons external to a shell deform it. (auth)

34445 EXCITATION OF HELIUM BY PROTONS AND HYDROGEN ATOMS AND POLARIZATION OF THE RESULTING RADIATION. J. Van Eck, F. J. De Heer, and J. Kistemaker (FOM-Laboratorium voor Massascheiding, Amsterdam). Physica, 30: 1171-96(June 1964).

Absolute excitation cross sections were determined for H^+ and H incident on He by measuring the intensities of the singlet and triplet lines of the He I spectrum. The energy range was mostly 5 to 35 kev; but for one ^1D and one ^1S level measurements were made up to 100 kev. The polarization of the photons was also determined. As a function of the energy, the cross section shows a similar behavior for different levels of a spectral series and decreases with increasing quantum number n. The polarization is almost the same for the emission lines of one series. Many maxima in the excitation cross sections are found at energies of about 15 kev for singlet and triplet excitation of helium. A tentative explanation is given in terms of formation of intermediate molecular states. Excitation of the 4^1D level by protons results in two maxima. The excitation of the 3^1P level and the degree of polarization of the 3^1P–2^1S transition show an energy dependence which differs from the existing theoretical results. In agreement with the spin conservation rule of Wigner, it was observed that the 3^3P level is excited much more effectively by H atoms than by protons. (auth)

34446 THE EXCHANGE SCATTERING OF A SLOW ELECTRON BY THE HYDROGEN ATOM. J. F. Waddington (London Univ.). Proc. Phys. Soc. (London), 84: 47-53 (July 1964).

The box variational method developed by Risberg and Percival is extended to include exchange in the one-state approximation. The computational labor involved in the calculations is greater than in the nonexchange case owing to the use of a nonorthogonal function basis which leads to a more general type of eigenvalue problem. Phase shifts are obtained for s-wave and p-wave scattering which compare well with those resulting from direct solution of the integro-differential equation for the problem. (auth)

34447 CONTINUUM DISTORTED WAVE APPROXIMATION; RESONANT CHARGE TRANSFER BY FAST PROTONS IN ATOMIC HYDROGEN. I. M. Cheshire (Glasgow Univ.). Proc. Phys. Soc. (London), 84: 89-98(July 1964).

The boundary conditions in the impact parameter treatment of ion–atom collisions are examined. It is shown that the Coulomb interaction between the bound electron and the incident ion gives rise to a phase term which is not included in previous treatments of this problem. An approximation which takes account of this phase is presented and applied to the resonant capture process $H^+ + H(1s) \rightarrow H(1s) + H^+$. First and second order cross sections are shown to have the asymptotic energy dependence of the impulse and second Born approximations, respectively. (auth)

34448 A NEAR-RESONANCE CHARGE TRANSFER PROCESS. P. H. Edmonds and J. B. Hasted (London Univ.). Proc. Phys. Soc. (London), 84: 99-109(July 1964).

The resonant single charge transfer cross section for the collision I^+-Hg ($\Delta E_\infty = 0.019$ ev) was measured in the impact energy range from 5 to 1200 ev. Narrow (~0.02 E_p) energy distribution of the incident ions was ensured by momentum analysis without subsequent retardation. Separation of the considerable elastic scattering component was achieved by slow charge collection at a single electrode in parallel electric and magnetic fields, and the energy distributions of the scattered ions were calculated. Despite large angle inelastic scattering, no enhancement of the cross section attributable to inward spiraling was found. (auth)

34449 NOTE ON DIFFUSION AND DRIFT OF POSITIVE IONS IN NEON. J. Dutton and E. M. Williams (University Coll. of Swansea, Eng.). Proc. Phys. Soc. (London), 84: 171-5(July 1964).

The drift velocity and the diffusion coefficient D for selected species of Ne ions in Ne were over the range $3 < E/p_0 < 45$ v cm^{-1} $torr^{-1}$, where p_0 is the pressure reduced to 0°C. Two species of ion having zero field mobilities of 4.0 and 7.5 cm^2 sec^{-1} v^{-1} were observed. The diffusion coefficient for the slower species increased from an approximately constant value at low values of E/p_0 and tended to the form $D \propto (E/p_0)^{1/2}$ at high values of E/p_0. Above a value of E/p_0 about 3 v cm^{-1} $torr^{-1}$, the energy of these ions was shown to increase with increasing E/p_0. (auth)

34450 INVESTIGATION ON MULTIPLE EMISSIONS OF SECONDARY ELECTRONS. Peter Haeussler (Johannes Gutenberg-Universitat, Mainz). Z. Physik, 179: 276-84 (1964). (In German)

CuBe- and NaCl-targets were bombarded by single electrons (100–600 ev). The secondary electrons accelerated by 40 kv strike the crystal of a scintillation counter, backed by a multichannel analyzer. The probability P_n of emission of n = 0, 1, 2, 3, ... secondaries can be found

from the pulse height distribution. The probability distribution $P_n = f(n)$ shows a characteristic deviation from a Poisson's distribution. There was no evidence that there is a preference for even numbers of n as found by others. (auth)

34451 PHONONS AND PHONON INTERACTIONS. Thor A. Bak, ed. Aarhus Summer School Lectures, 1963. New York, W. A. Benjamin, Inc., 1964. 651p. $9.50.

Separate abstracts were prepared for six of the fifteen lectures included. One lecture was previously abstracted in NSA (17: 15229). Other lectures are on the free phonon field, phonon-phonon interactions, electron-phonon interactions in semiconductors, phonon interactions and spectra, phonons in liquids, phonons and lattice imperfections, microwave ultrasonics, and energy transport in organic crystals. (D.C.W.)

For abstracts of individual papers see: 34452, 34453, 34454, 34455, 34624, and 34722.

34452 INTERACTION OF X-RAYS WITH PHONONS. W. Cochran (Cambridge Univ., Eng.). p.102-18 of "Phonons and Phonon Interactions." New York, W. A. Benjamin, Inc., 1964.

X-ray scattering by crystals is treated in which the energy communicated to the system is very small in relation to the energy of the x-ray photon. Both Bragg and thermal scattering are considered. The Debye-Waller factor due to the thermal motion of the atoms is discussed, and it is shown that the Debye temperature which fits the Debye-Waller factor will not be the same as that which fits the specific heat. Some x-ray measurements related to lattice dynamics are reviewed. (D.C.W.)

34453 THE ELECTRON-PHONON INTERACTION. John J. Quinn (RCA Labs., Princeton, N. J.). p.119-37 of "Phonons and Phonon Interactions." New York, W. A. Benjamin, Inc., 1964.

The adiabatic approximation for treating electron-phonon interactions in solids is discussed, and the rigid ion model is considered. The Green's function approach to the electron-phonon interaction is also outlined. (D.C.W.)

34454 THE INTERACTION OF LONG-WAVELENGTH PHONONS WITH ELECTRONS. A. R. Mackintosh (Ames Lab., Ames, Iowa). p.181-220 of "Phonons and Phonon Interactions." New York, W. A. Benjamin, Inc., 1964. (IS-685)

The investigation of electron-phonon interactions using ultrasonic techniques is considered. Methods for calculating the ultrasonic absorption in a free electron gas with and without applied magnetic fields and in real metals are reviewed, together with the quantum of phonon absorption. Magnetoacoustic effects in pure metal crystals are then reviewed and explained in terms of the theory. The effect of the superconducting transition on ultrasonic attenuation is also discussed. (D.C.W.)

34455 PHONONS AND NEUTRON SCATTERING. B. N. Brockhouse (McMaster Univ., Hamilton, Ont.). p.221-75 of "Phonons and Phonon Interactions." New York, W. A. Benjamin, Inc., 1964.

The experimental and theoretical factors involved in determining the dispersion relations, frequency distributions, and decay properties of lattice vibrations in perfect crystals by neutron spectroscopy are reviewed. Semiclassical neutron scattering theory, dispersion relations at low temperature, and temperature effects on neutron groups and dispersion curves are considered. Neutron experiments on lattice dynamics are reviewed. The agreement with theoretical predictions is discussed. 75 references. (D.C.W.)

34456 PARTIAL STOPPING POWERS OF H_2 AND He GASES FOR HELIUM ATOMS AND IONS. J. Cuevas, M. Garcia-Munoz, and P. Torres. 13p. (CONF-452-31)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

The case is considered where the charge state of the projectile is continuously altered by capture and loss of electrons in the target gas. The charge changing process contributes a term to the total energy loss. (R.E.U.)

34457 A TRANSIENT SOLUTION OF THE FOKKER-PLANCK EQUATION. C. F. Eaton (Raytheon Co., Bedford, Mass.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-382, 3p. $1.00. (CONF-600-36)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The temporal behavior of the electron distribution function in a uniform, slightly ionized gas is analyzed. It is shown that if, and only if, the collision frequency is velocity independent will the transient distribution function be a Maxwellian distribution. The general solution for this case is presented in which it is assumed that the electron and gas temperatures are initially different and that the gas temperature and density have arbitrary time variations. Also presented are closed form solutions for various temperature variations. A method is outlined whereby an approximate solution in terms of tabulated functions can be obtained for arbitrary variations of gas temperature and density. (auth)

34458 INTERACTION OF VERY INTENSE RADIATION FIELDS WITH AN ATOMIC SYSTEM. THE INVERSE RAMAN EFFECT. Oldwig von Roos (California Inst. of Tech., Pasadena). 25p. (CONF-452-11)

From American Physical Society, Washington, D. C., Apr. 1964.

A theory is developed by which radiation processes involving a large number of photons in first or second order perturbation theory can be treated. The theory is applied to the interaction of an atomic electron with a very intense linearly polarized laser beam. It is found under certain approximations that induced radiation will occur at all harmonics $\eta\omega_0$ of the fundamental laser frequency ω_0. The intensity distribution of this radiation is symmetric about the axis of polarization of the primary beam and is peaked at an angle of about 45° with respect to direction of propagation of the secondary radiation and the polarization of the incident radiation for the first few modes. This angle markedly shifts toward 0° for increasing n (higher harmonics). The transition probabilities are high enough to make the effect readily observable. (auth)

34459 MEASUREMENT OF THE ANGULAR DISTRIBUTION OF BREMSSTRAHLUNG INTENSITY FOR 10 Mev AND 20 Mev ELECTRONS ON THICK TARGETS. C. P. Jupiter, C. R. Hatcher, and N. E. Hansen (Univ. of California, Livermore). 14p. (CONF-452-14)

From American Physical Society, Washington, D. C., Apr. 1964.

The intensity distributions of bremsstrahlung produced by 10- and 20-Mev electrons on Al (1.7 in. thick) and Ta (0.196 in. thick) targets were measured and compared with calculations made with the Schiff formula. The calculated distributions were about twice as broad in angle as the measured values. (D.C.W.)

34460 A CALCULATION OF THE SCATTERING FUNCTION $S(k,\omega)$ FOR THE INELASTIC SCATTERING OF NEUTRONS BY ANHARMONIC CRYSTALS. V. Ambegao-

kar and A. A. Maradudin (Westinghouse Research Labs., Pittsburgh). 44p. (CONF-452-12)

From American Physical Society, Washington, D. C., Apr. 1964.

A numerical calculation is presented of van Hove's scattering function $S(\underline{k},\omega)$, which describes the inelastic scattering of neutrons by an anharmonic crystal with the transfer of momentum $\underline{k}$ and energy ω from neutron to crystal. Two contributions to $S(\underline{k},\omega)$ are included in the present calculation: the leading term which describes the broadening and shift of the one phonon peak, and the leading term which describes the interference between the one phonon peak and the diffuse multiphonon background. The calculations of $S(\underline{k},\omega)$ as a function of ω for fixed $\underline{k}$ are carried out in the high temperature limit for a nearest neighbor, central force model of a fcc crystal which is chosen to approximate lead. In the cases treated the interference terms represent only a very small correction to the one phonon peak. (auth)

Cosmic Radiation

34461 (NASA-TT-F-126) COSMIC RAYS. S. N. Vernov and L. I. Dorman, eds. Translation of "Kosmicheskiye Luchi," from IGY Program, Section VII, No. 3 Izdatel'stov Akademii Nauk SSSR, Moscow, 1961. 297p.

Articles contributed to the IGY Program as section VII, number 3, printed by The USSR Publishing House of the Academy of Sciences, are presented. The contents are concerned with recent concepts on the variation of cosmic rays and their use in investigations of geophysical and astrophysical phenomena. The use and operation of cubical and azimuthal telescopes, plastic scintillators, and radiosonde in registration of cosmic ray intensity are discussed. Results are presented from investigations made at different stations and altitudes. Meteorological effects are included. Separate abstracts were prepared for the 18 papers included. (auth)

For abstracts of individual papers see: 33887, 33888, 33889, 33890, 34462, 34463, 34464, 34465, 34466, 34467, 34468, 34469, 34470, 34471, 34472, 34473, 34474, and 34475.

34462 (NASA-TT-F-126(p.2-80)) RECENT CONCEPTS OF THE VARIATIONS OF COSMIC RAYS. L. I. Dorman. (A translation)

Observations and possible explanations of cosmic radiation intensity variations are discussed. 202 references. (R.E.U.)

34463 (NASA-TT-F-126(p.81-101)) INVESTIGATION OF THE TEMPORAL VARIATIONS OF THE DIFFERENT COMPONENTS OF COSMIC RAYS IN RELATION TO OBSERVATIONS MADE AT A SINGLE POINT. A. I. Kuz'min, N. N. Yefimov, D. D. Krasil'nikov, G. V. Skripin, V. D. Sokolov, G. V. Shafer, and Yu. G. Shafer. (A translation)

Variations of cosmic rays, registered by apparatus sensitive to different parts of the energy spectrum and located at the same point, are shown to point to the broad possibilities of analyzing the nature of such variations and the electromagnetic properties of the environs of the solar system and the galaxy, as well as certain indirect data on elementary particle interactions. It is clear that these possibilities would be considerably extended, if material were provided by a worldwide network of stations. (auth)

34464 (NASA-TT-F-126(p.180-6)) INVESTIGATION OF THE VARIATIONS OF COSMIC RAYS AT ALTITUDES OF 9-12 KILOMETERS. L. T. Baradzey, Yu. I. Logachev, and P. P. Shiskhov. (A translation)

A device for measuring the total ionizing radiation, the penetrating component, and the neutron component of cosmic rays is described. Gas-discharge counter telescopes, lead-filter telescopes, and paraffin-lead-shielded neutron detectors were used. Results are given for altitudes of 9 to 12 km during magnetically quiet and active days. (R.E.U.)

34465 (NASA-TT-F-126(p.187-93)) SOME RESULTS OF STRATOSPHERIC INVESTIGATIONS OF THE INTENSITY OF COSMIC RAYS AT YAKUTSK. Yu. G. Shafer and V. D. Sokolov. (A translation)

A coincidence counter telescope and radiosonde for stratospheric cosmic-ray intensity measurements are described, and results are given for periods of magnetic activity (SC). Seasonal changes in stratospheric cosmic-ray intensity with atmospheric density changes are discussed. (R.E.U.)

34466 (NASA-TT-F-126(p.194-214)) ON METHODS OF INTRODUCING METEOROLOGICAL CORRECTIONS INTO COSMIC-RAY INTENSITY DATA. E. (Ye.) S. Glokova, L. I. Dorman, and N. S. Kaminer. (A translation)

The introduction of corrections in cosmic-ray data because of the barometric effect and the temperature effect—the change in cosmic-ray intensity corresponding to a change in pressure or temperature at the observation level, respectively—is discussed. (R.E.U.)

34467 (NASA-TT-F-126(p.215-19)) THE BAROMETRIC COEFFICIENT OF THE NEUTRON COMPONENT. A. V. Sergeyev and A. A. Luzov. (A translation)

The calculation of the barometric coefficient by the method of multiple correlation is described. (R.E.U.)

34468 (NASA-TT-F-126(p.220-3)) METEOROLOGICAL COSMIC-RAY EFFECTS BELOW GROUND. Ya. L. Blokh, L. I. Dorman, and M. M. Dubrovin. (A translation)

Calculated and observed meteorological effects on cosmic-ray data for various depths below ground are given for Moscow (40 mwe) and Yakutsk (60 mwe). (R.E.U.)

34469 (NASA-TT-F-126(p.224-9)) EMPIRICAL DETERMINATION OF THE TEMPERATURE EFFECT FOR THE HARD COMPONENT OF COSMIC RAYS OVER HEISS ISLAND. M. I. Tyasto. (A translation)

An empirical determination of atmospheric effects on cosmic-ray intensity data for surface measurements over Heiss Island during 1958 to 59 is given. (R.E.U.)

34470 (NASA-TT-F-126(p.230-64)) CALCULATION OF THE INTEGRAL MULTIPLICITY OF μ-MESON PRODUCTION IN THE EARTH'S ATMOSPHERE FOR OBSERVATION UNDER DIFFERENT THICKNESSES OF ABSORBER. L. I. Dorman. (A translation)

The integral multiplicity is evaluated assuming that the first interaction of the primary particles with air occurs at λ g/cm^2, where λ is the interaction mean free path, and subsequent collisions occur discretely at 2λ, 3λ, etc.; ionization losses and meson(μ) decay are considered. The fluctuations are then calculated more accurately for the depths of the first and subsequent collisions, the production of mesons(π), and their capture and decay into mesons(μ). The differential spectra of mesons(μ) at sea level and various depths below ground and the variations of intensity with depth may then be found. (R.E.U.)

34471 (NASA-TT-F-126(p.265-72)) COUPLING COEFFICIENTS FOR THE PRIMARY AND SECONDARY

VARIATIONS OF COSMIC RAYS IN THE HIGH-ENERGY REGION. L. I. Dorman. (A translation).

Coupling coefficients for meson(μ) production at sea level beneath different thicknesses of absorber are calculated, and the conversion of secondary variations to primary variations at the top of the atmosphere is discussed. (R.E.U.)

34472 (NASA-TT-F-126(p.273-9)) EFFECT OF CHANGES IN SOLAR ACTIVITY ON THE COUPLING COEFFICIENTS BETWEEN PRIMARY AND SECONDARY VARIATIONS OF COSMIC RAYS. SOME PRACTICAL PROBLEMS REGARDING THE DETERMINATION OF THE SPECTRUM OF THE VARIATIONS. L. I. Dorman. (A translation)

Equations and graphical representations are given for periods of minimum and maximum solar activity. (R.E.U.)

34473 (NASA-TT-F-126(p 280-5)) THE METEOROLOGICAL EFFECTS IN RELATION TO THE FREQUENCY OF EXTENSIVE AIR SHOWERS NEAR SEA LEVEL. D. D. Krasil'nikov. (A translation)

A method of introducing geometric corrections in the analyses of barometric effects in relation to the frequency of EAS of varying size is discussed. The absorption mean free path of showers in the atmosphere and the effective mean free path of shower particles were examined as functions of the power of EAS or the total number of particles. (R.E.U.)

34474 (NASA-TT-F-126(p.286-91)) ON THE ORIGIN OF LARGE IONIZATION BURSTS OBSERVED UNDER DENSE MATERIALS NEAR SEA LEVEL. D. D. Krasil'nikov. (A translation)

An evaluation of the contributions of meson(μ) showers to the observed burst frequency near sea level is presented for an argon-filled lead-shielded high-pressure chamber. It is concluded that the greater part of the large ionization bursts is due to interacting particles rather than mesons(μ). Information on the spin and magnetic moment of mesons(μ) was obtained. (R.E.U.)

34475 (NASA-TT-F-126(p.292-4)) ON THE PROBLEM OF THE TEMPORAL DISTRIBUTION OF EXTENSIVE AIR SHOWERS OF COSMIC RAYS. N. N. Yefimov. (A translation)

An experiment is described for investigating the frequency distribution of EAS from the shape of the time-distribution function for short time intervals between showers (1500 showers per hour). The applicability of Poisson's law for time intervals to 1 sec was investigated. (R.E.U.)

34476 THE SIGNIFICANCE OF SOME MEASUREMENT RESULTS IN COSMIC RADIATION RESEARCH FOR NUCLEAR PHYSICS. K. Pinkau (Institut für Reine und Angewandte Kernphysik, Kiel). Fortschr. Physik, 12: 139-234(1964). (In German)

An attempt was made to represent various measurement results in cosmic radiation physics in a uniform manner. A cascade theory was developed with which the spectra of the secondary particles could be derived from the primary spectra. It was shown that good agreement could be obtained between the various measurement results when the spectra measured in accelerators were extrapolated to higher energies. With the help of the cascade theory it is also possible to refine the air shower theory. The position and height of air shower maxima were shown with examples. (tr-auth)

34477 ČERENKOV SCINTILLATION COUNTER MEASUREMENTS OF THE INTENSITY AND MODULATION OF LOW RIGIDITY COSMIC RAYS AND FEATURES OF THE GEOMAGNETIC CUTOFF RIGIDITY. W. R. Webber (Univ. of Minnesota, Minneapolis) and F. B. McDonald. J. Geophys. Res., 69: 3097-3114(Aug. 1, 1964).

The primary cosmic radiation was measured with a Čerenkov scintillation counter at various times in the solar cycle at locations having nominal cutoff rigidities of 0.8, 1.6, and 2.7 Bv. The results were used here to delineate spectral features of low rigidity protons and alpha particles and to examine the rigidity and charge dependence of the eleven-year solar modulation. Details of particle transmission near the geomagnetic cutoff are also examined. The measurements are compared with other observations and models. (auth)

34478 NEUTRON ALBEDO MEASUREMENTS ON POLAR ORBITING SATELLITES. J. H. Trainor and J. A. Lockwood (Univ. of New Hampshire, Durham). J. Geophys. Res., 69: 3115-23(Aug. 1, 1964).

An experiment to measure the earth's neutron albedo was flown on three polar orbiting Agena satellites in 1962. The detector, a BF_3 counter within a moderator, was surrounded by a ring of charged-particle proportional counters to discriminate against neutrons produced by protons in the detector assembly. The results show an albedo flux of 0.085 ± 0.03 n/cm^2 sec at the equator at 300-km altitude, in agreement with the rocket measurements of Bame and the calculations of Lingenfelter. However, at high latitudes a value of 0.24 ± 0.06 n/cm^2 sec was obtained, a factor of 4 below the calculations of Lingenfelter. The calculations used to estimate the neutron production by primary cosmic protons on the detector assembly and the vehicle itself are outlined and compared with the experimental measurements of production in the detector assembly. (auth)

34479 POSITRON-ELECTRON RATIO OF PRECIPITATING ELECTRONS. Laurence E. Peterson (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 69: 3141-53 (Aug. 1, 1964).

A balloon observation of the x-ray spectrum from 37 to 700 kev over Minneapolis during the July 1961 solar event series gave an upper limit on the ratio of positrons to electrons during a precipitation as well as on other geophysical processes. The electrons caused the x-ray bursts; no large fluxes above cosmic-ray-produced background were observed above about 400 kev. The excess flux at 0.5 Mev, which would be caused by positrons annihilating, was 0.051 ± 0.043 photon cm^{-2} sec^{-1} over a 68-minute interval at 2100 UT (1500 local) on July 13. No solar protons of energies greater than air cutoff (80 Mev) were observed during the flight. A limit of 33 ± 26 protons cm^{-2} sec^{-1} in the 1-15 Mev range was obtained from the 0.5-Mev flux, which would be produced via nuclear reactions. During the same interval a flux of 2×10^3 protons cm^{-2} sec^{-1} of 1-15 Mev solar protons was observed at 1000 km only a few geomagnetic degrees farther north. The differential electron spectrum producing the x rays was fitted to a power law in energy with an exponent of 5.4. The average rate of electron precipitation was 6.4×10^7 electrons cm^{-2} sec^{-1} > 37 kev, or 2.6×10^{10} cm^{-2} over the 68-min interval. This would deplete the outer zone of electrons in a few minutes, implying a steady and efficient acceleration mechanism. The limit on the ratio of precipitating positrons to electrons is $(4 \pm 3) \times 10^{-10}$, which is also probably typical for electrons in the earth's magnetosphere and may even apply to the interplanetary medium and the solar corona. (auth)

34480 LARGE DIURNAL VARIATIONS OF GEOMAGNETICALLY TRAPPED AND OF PRECIPITATED ELEC-

TRONS OBSERVED AT LOW ALTITUDES. L. A. Frank, J. A. Van Allen, and J. D. Craven (State Univ. of Iowa, Iowa City). J. Geophys. Res., 69: 3155-67(Aug. 1, 1964).

The diurnal variation of the intensities of geomagnetically trapped electrons and of precipitated electrons were observed to be similar in data obtained with Injun 3 over the period from December 1962 to September 1963. The northern limit of detectable electron ($E \geq 40$ kev) intensities was at $L \simeq 20$ ($A \simeq 77°$) at local noon and at $L \simeq 8$ ($A \simeq 69°$) at local midnight. Several polar plots of the median intensities of electrons as a function of local time and the shell parameter L (and $A = \text{arc cos } L^{-\frac{1}{2}}$) are presented. A local acceleration mechanism for electrons ($E \geq 40$ kev) on the sunward side of the magnetosphere is suggested by an apparent maximum of precipitated electron intensities near local noon at $L \sim 8$. The diurnal effect (a factor of the order of 100 or greater) begins abruptly at $L \sim 8$ and extends to all higher L shells; the local time dependence of the median electron intensities is more or less symmetrical about the noon-midnight meridian, but may be more nearly symmetrical about a meridian of ~1100 (±2 hours) beyond $L \sim 10$. (auth)

34481 SOLAR MODULATION EFFECTS ON THE PRIMARY COSMIC RADIATION NEAR SOLAR MINIMUM. V. K. Balasubrahmanyan and F. B. McDonald (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 69: 3289-92(Aug. 1, 1964).

The differential rigidity spectra of H and He nuclei (100 to 600 Mev/mc), the integral H and He flux (>600 Mev/mc), and the cosmic-ray charge spectra in the range z = 1 to 8 were measured using an improved Čerenkov scintillation counter flown by balloon from Fort Churchill, Canada, in June 1963. The results are compared with other observations. (D.C.W.)

34482 MODULATION OF LOW-ENERGY GALACTIC COSMIC-RAY HYDROGEN AND HELIUM. C. E. Fichtel, D. E. Guss, D. A. Kniffen, and K. A. Neelakantan (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 69: 3293-5(Aug. 1, 1964).

The differential rigidity spectra of protons and He nuclei were measured by balloon flights of nuclear emulsions from Fort Churchill, Canada, in 1962 and 1963. The results are compared with similar observations for 1961. (D.C.W.)

34483 A STUDY OF CORE STRUCTURE IN EXTENSIVE AIR SHOWERS BY MEANS OF LARGE CLOUD CHAMBER. Tatsunosuke Kaneko (Osaka City Univ.). J. Phys. Soc. Japan, 19: 785-99(June 1964).

The core of EAS was observed by large multiplate cloud chamber and scintillation detectors. Cloud chamber pictures were obtained by various triggering methods. Fluctuation of core structure was shown by many typical cloud chamber pictures and were discussed on them at point of view of these pictures. No high energy particle with energy $>10^{12}$ ev was found over 2m from the axis of EAS. For a small air shower, characters of the core vary largely even for the same size and age. Proportion of cores which consist of only electromagnetic cascade shower are about a half. On the other hand, particle density and energy density show small fluctuation for large size air shower of $s > 0.8$. As special example, double core and mu-meson bundle events are found and analyzed. A lateral distribution of mean energy of electromagnetic component is expressed by $\overline{E} = 1.3 \times 10^9 \, r^{-(0.6 \pm 0.15)}$ ev in region 0.5 to 15m from the shower axis. (auth)

34484 DENSITY SPECTRUM OF CHARGED PARTICLES IN EXTENSIVE AIR SHOWERS. Itsuo Katsumata (Osaka City Univ.). J. Phys. Soc. Japan, 19: 800-14(June 1964).

A density spectrum of extensive air showers was obtained by means of a plastic scintillator at a mountain altitude, 2770 m above sea level. In the range from 50 to 10^4 particles/m^2, the integral density spectrum is expressed as $\Delta^{-1.55 \pm 0.05}$. By an EAS array the accompanied EAS's were also observed, and their contributions to the density spectrum were analyzed. The results are as follows. There is no agreement between the exponent of density spectrum and that of size spectrum which was obtained directly from EAS array data in this experiment. This is due to the fact that when the size of EAS is larger, the lateral structure of the central region becomes steeper. Moreover, the lateral structure fluctuates considerably in the same size showers. The exponent of the density spectrum seems to decrease gradually with increasing altitude, the value on the mountain is 10% smaller than that of the sea level. Though statistical error is large, the exponent of the integral density spectrum increases from 1.55 to 2.0 above the density 2×10^4 particles/m^2. (auth)

34485 MESON PRODUCTION AT HIGH ENERGIES AND THE PROPAGATION OF COSMIC RAYS THROUGH THE ATMOSPHERE. Yash Pal and B. Peters. Kgl. Danske Videnskab. Selskab, Mat.-Fys. Medd., 33: No. 15, 1-15 (1964).

An analysis of the intensity, charge composition, and energy spectra of secondary cosmic ray components suggests that the average incident extra-terrestrial nucleon, in its passage through the atmosphere, is repeatedly excited to one of the low-lying levels of the pino-nucleon system and decays between successive excitations by the emission of several mesons. The particle distribution in the atmosphere in the energy range between a few Bev to ~1000 Bev can be understood and calculated accurately in terms of such decay products and their progeny; other processes of meson production play only a minor role. The experimental data available on secondary cosmic radiation determine approximately the properties of the excited "average" baryon state, rather similar to those known to exist at accelerator energies. (auth)

34486 ON COSMIC RAYS AS AN EXTRAGALACTIC PHENOMENON. G. R. Burbidge (Univ. of California, San Diego) and F. Hoyle. Proc. Phys. Soc. (London), 84: 141-50(July 1964).

Although it is possible that the energy spectrum of cosmic rays may arise directly in violent events in the nuclei of galaxies, the characteristic spectrum dE/E^{-r} ($r = 2.5$ to 3) can also be due to the operation of a Fermi process on an extragalactic scale. It is shown that, provided the rate of energy gain for the whole cosmic-ray distribution is greater than the rate at which energy is injected and provided that the process reaches a steady state, the spectral index must lie between 2 and 3. An upper limit to the particle energies is to be expected when Larmor radii become comparable with the dimensions of the accelerating elements. This condition, applied to a particle energy of the order of 10^{20} ev, leads to a dimension of about 10 megaparsec, if the acceleration process is extragalactic in origin. (auth)

34487 MEAN SQUARE LATERAL DEVIATION FOR ELECTRONS IN A CASCADE SHOWER. Akeo Misaki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 716-18 (Apr. 1964).

Mean square lateral deviations for electrons were computed for a photon-initiated shower. Numerical results

were obtained and compared with results of Monte Carlo calculations. (D.C.W.)

34488 ATMOSPHERIC ČERENKOV RADIATION FROM COSMIC-RAY AIR SHOWERS. Forrest I. Boley (National Center for Atmospheric Research, Boulder, Colo.). Rev. Mod. Phys., 36: 792-808(July 1964).

Experimental and theoretical investigations of the emission of Cherenkov light by the electrons of an extensive air shower are reviewed. 40 references. (D.C.W.)

34489 INVESTIGATION OF THE COMPOSITION OF THE PRIMARY COSMIC RADIATION ON THE BASIS OF THE FLUCTUATIONS OF THE CHERENKOV RADIATION IN THE BROAD ATMOSPHERIC SHOWERS. N. M. Nesterova and S. I. Nikol'skii (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 46: 1908-11(May 1964). (In Russian)

The composition of the cosmic radiation in the energy range beyond 10^{14} ev was studied up to now by analyzing broad atmospheric showers or by comparing the relative intensities of the electron and μ-meson components of the showers. In an attempt to develop a new method for this purpose, the Cherenkov flash which accompanies the passage of the showers through the atmosphere and measurement of the number of particles were used for the study of the primary radiation, determining the fluctuations of the ratio of the light intensity Q of the flash and the number of the particles in the shower. The following correlation was used in the determination of the dependence of this ratio on the energy of the primary nucleus possessing A nucleons, in the shower: $Q/N \sim (E_0^N/A)^{\beta-\alpha}$, in which α and β are the exponents in the $N \sim E_0^{\alpha}$ and $Q \sim E_0^{\beta}$ relations. Previous studies revealed that at 3860 m above the sea level, in Cherenkov radiations with $N = 10^5$ to 10^7 particles, the value of $\beta - \alpha = 0.2 \pm 0.05$. On the basis of this correlation, 2 variants of the cosmic radiation were calculated, assuming that they were initiated by proton-induced showers. It was found that the distribution is markedly dependent on the composition of the primary cosmic radiation. The fluctuations reflect the errors in the original measurements. If this is taken into account, there is no agreement between calculation and measurements, assuming that the primary radiation is enriched in heavy nuclei. (TTT)

34490 POLARIZATION OF COSMIC RAY MUONS OF VARIOUS ENERGIES. T. L. Asatiani, V. M. Krishchyan, and R. O. Sharkhatnyan (Inst. of Physics, Erivan). Zh. Eksperim. i Teor. Fiz., 46: 1929-36(June 1964). (In Russian)

The absolute values of polarization of 0.14, 0.25, 0.30, 1.45, and 2.0 Bev cosmic muons are determined. The ratios K^+/π^+ and $K^+/(K^+ + \pi^+)$ for energies $E_\mu < 1.0$ Bev and $E_\mu > 1.0$ Bev are calculated. The effective energy of the nucleons producing the kaons and pions is estimated. (auth)

34491 THE ENERGY SPECTRUM AND COMPOSITION OF COSMIC RAYS OF GALACTIC AND METAGALACTIC ORIGIN. Yu. A. Fomin and G. B. Khristiansen (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 46: 2141-50 (June 1964). (In Russian)

Results are presented of a calculation of the energy spectrum and composition of the primary cosmic radiation of galactic and metagalactic origin which are based on the diffusion model of propagation of cosmic rays and on the assumption that a certain dependence of the diffusion coefficient of cosmic rays on energy exists. The results of the calculations are compared with the experimental results on the spectrum of extensive air showers with respect to particle number; the results are also compared with the μ-meson distribution in showers with a given number of particles. The results of the comparison lead to the result that cosmic rays of metagalactic origin should play a significant role in the energy region $E > 10^{17}$ ev. (auth)

34492 COMPOSITION OF THE SECONDARY PARTICLES PRODUCED IN NUCLEAR INTERACTION AT $\sim 10^{12}$ ev. C. O. Kim (Univ. of Chicago). 74p. (CONF-46-117)

From American Physical Society 1963 Spring Meeting, Washington, D. C., Apr. 1963.

Twenty-two proton, neutron, and alpha jets ($N_h \leq 3$, 2×10^{11} ev $< E < 1.5 \times 10^{13}$ ev) found in a 22-l emulsion stack flown for 13 hr at an altitude of 116,000 ft were analyzed to identify the particles emitted in the extreme backward center-of-mass cone. Among 82 tracks analyzed, out of 140 tracks traced (total length of the secondaries traced was 20.4 m, and 74 interactions were found), 53 secondaries were attributed to pions, eighteen to kaons, ten to protons, and one to a hyperon. The relative composition of the 82 secondaries has a dependence on the center-of-mass emission angle $\bar{\theta}$. For $\bar{\theta} \geq 175°$, there were 7π, 9K, 10 p, and 1 Y; for $\bar{\theta} < 175°$, there were 46 π, 9 K, and no baryons. Similar distinction existed for the average center-of-mass momenta $\langle \bar{p} \rangle$ and average transverse momenta $\langle p_t \rangle$. The baryons carried the average fraction 0.5 ± 0.2 of the total available energy in the center-of-mass system. For the K/π ratio, p_t distribution, and $\langle \bar{p} \rangle$ at $\bar{\theta} < 175°$, the hydrodynamical theory predicts the correct behavior. For $\bar{\theta} \geq 175°$, an interpretation in terms of the Heisenberg theory is favored. (auth)

34493 INJUN I OBSERVATIONS DURING LATTER SEPTEMBER–EARLY OCTOBER 1961. J. A. Van Allen and W. A. Whelpley (State Univ. of Iowa, Iowa City). 7p. (CONF-402-6)

From American Geophysical Union 43rd Annual Meeting, Washington, D. C., Apr. 1962.

Preliminary results are presented for observations made on the energy and intensity of electrons and solar protons at 880 to 1010 km over North America and the North Atlantic during the period Sept. 28 through Oct. 4, 1961. Data were obtained during orbital arcs ranging through magnetic shells with L values from 2 to 25 earth radii. The satellite instrumentation is briefly described. (D.C.W.)

Criticality Studies

34494 (CEA-R-2495) EXPERIENCES DE CRITICITE SUR DES CYLINDRES ANNULAIRES CONTENANT DES SOLUTIONS DE PLUTONIUM. (Criticality Experiments with Annular Cylinders Containing Plutonium Solutions). Michel Molbert, André Sauve, Michel Houelle, and Edouard Deilgat (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). June 1964. 59p.

Preliminary results are given from criticality analyses of annular cylinders containing plutonium solutions. Results are plotted for cylinders with light water reflectors, cadmium screens, and plutonium concentrations of 42.3 to 104.1 g/l. (R.E.U.)

34495 (GA-5404) ON THE ANALYSIS OF PULSED, MULTIPLYING SYSTEMS. Noel Corngold (General Atomic Div. General Dynamics Corp., San Diego, Calif.). June 24, 1964. Contract AT(04-3)-167. 13p.

A study of $C(\vec{R})$, a quantity introduced into the study of pulsed, multiplying system by Garelis and Russell, is presented. The analysis is carried out in the general case of multi-velocity transport theory in a system with spatially varying properties—quite different from the one-velocity diffusion theory model of GR. Explicit formulas for C(R)

are given in terms of slowing-down kernels, and the connection between C and reactivity is shown. It appears that defining reactivity through $\rho = \overline{C} - \alpha/\overline{C}$ leads to a reasonable "reactivity scale," and that the calculation of C(R) from "first principles" should not be too difficult. (auth)

34496 PROMPT-NEUTRON LIFETIME IN CRITICAL ENRICHED-URANIUM METAL CYLINDERS AND ANNULI. John T. Mihalczo (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 20: 60-5(Sept. 1964).

Prompt-neutron lifetimes were determined for unreflected and unmoderated critical assemblies of enriched-uranium metal (93.15% ^{235}U) in cylindrical geometry. Five solid cylinders ranging in diameter from 7 to 15 in. and three cylindrical annuli having outside diameters as large as 15 in. were assembled to delayed critical, and prompt-neutron decay constants were measured by the Rossi-α technique. The prompt-neutron lifetimes were determined from the measured decay constants, and effective delayed-neutron fractions were obtained by S_n multigroup transport-theory calculations, which predicted multiplication constants of all assemblies to within $\frac{1}{2}\%$. For solid cylinders, the lifetime value was 6.25 ± 0.04 nsec, which, within the limits of experimental errors, is independent of the dimensions of the cylinders and agrees with the lifetime of 6.2 ± 0.1 nsec obtained from earlier prompt-neutron decay-constant measurements with a uranium sphere (Godiva I). For the cylindrical annuli, the lifetime varied from 7.0 to 8.0 nsec. The increase in the lifetime value over that of the solid cylinders is due to the time required for neutrons to cross the center void. (auth)

Direct Energy Conversion

Refer also to abstracts 34001, 34002, and 35204.

34497 (NP-12888(Vol.5)) SPACE ELECTRIC POWER SYSTEMS STUDY. VOLUME 5. D.C. TO D.C. CONVERTERS FOR NUCLEAR-THERMIONIC ENERGY SOURCES. Final Report, May 3—December 3, 1963. A. R. Baker, D. L. Bowles, G. E. Gerecke, E. L. Ingalls, J. W. Ogden, and E. F. Swiderski (Westinghouse Electric Corp. Aerospace Electrical Div., Lima, Ohio). Contract NAS 5-1234. 228p. (N64-25918; NASA-CR-55800)

An investigation is presented of megawatt d.c.-to-d.c. converters to be used with space ion-thrustor electric-propulsion systems operating from a nuclear-thermionic energy source. A preliminary design was made to identify the functional blocks that are common to all the converters considered. Based on the preliminary design, a parametric investigation was made for each functional block at several different power levels and input voltages. The results include parametric data in tabulated and graphic form, identification of problem areas, analysis, and recommendations. An analysis of the voltage transients caused by arcing faults in electric engines is also presented. (auth)

34498 (UCRL-11334) THE ENERGY CONVERSION CHARACTERISTICS OF A BRUSHLESS DIRECT CURRENT SERVOMOTOR (thesis). Donald Raymond Machen (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 16, 1964. Contract W-7405-eng-48. 54p.

The energy conversion characteristics of a direct-current servomotor without commutating brushes are investigated. The development of the excitation system and the final characteristic parameters of the brushless machine are considered. The analytic treatment of the energy-conversion mechanism within the machine is carried out by the application of Maxwell's equations in the air gap. An expression for the electrically developed torque is derived (by energy methods), which is applicable to the brushless machine within the limits of the assumptions made. (auth)

34499 PROGRESS ON ADVANCED METHODS OF POWER GENERATION. H. A. Wagner (Detroit Edison Co.). EEI (Edison Elec. Inst.) Bull., 222-9(June-July 1963).

A review of the advanced methods of power generation is presented. Thermoelectric generation, thermionic generation, MHD generation, fuel cells, fusion reactors, superconductivity, and lasers are discussed. Predictions as to the size, cost, time, and nature of commercial applications are included. (C.E.S.)

34500 NUCLEAR BATTERIES. Jiri Kopecky and Josef Kajfosz (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 10: 203-10 (June 1964). (In Czech.)

A review is given on the direct conversion of nuclear into electric energy. Individual direct conversion methods are described and compared together from the point of view of its properties and utilization possibilities. The main perspectives of further development of this branch are indicated. (auth)

34501 THE PERFORMANCE OF ELECTROGASDYNAMIC GENERATORS. M. C. Gourdine, E. Barreto, and M. P. Khan (Curtiss-Wright Corp., Wood-Ridge, N. J.). 27p. (CONF-542-7)

From 5th Symposium of the Engineering Aspects of Magnetohydrodynamics, Cambridge, Mass., Apr. 1964.

The advantage of using long slender channels, in parallel, over short broad channels, in series, as the conversion unit is discussed. Electrical interaction between colloidal ions and neutral molecules is shown to influence aerodynamic performance, placing limitations on the maximum possible efficiency for a power generator. The effects of wall friction and Joule heating are considered. The theory presented agrees with existing experimental data and indicates the performance of a power generating unit can be improved. (auth)

34502 A CESIUM PLASMA CAPILLARY EMITTER AS A SOURCE OF CESIUM IONS OR A SOURCE OF ELECTRONS OF HIGH CURRENT DENSITY. H. Huber, R. Le Bihan, and D. Maugis (Compagnie Generale de Telegraphie Sans Fil, Orsay, France and Centre de Physique Electronique et Corpusculaire, Orsay, France). 29p. (CONF-407-3)

From Electro Chemical Society, Toronto, May 1964.

Electron and ion extraction from a capillary emitter and a cylindrical cavity emitter with an effusion hole on top were investigated experimentally. A suitable model for the cavity emitter was obtained and applied to the capillary emitter as well. Apparently, capillary emitters as well as cavity emitters with a small hole can be used either as an electron source or an ion (cesium) source. (D.C.W.)

34503 COMPACT, LIGHTWEIGHT THERMOELECTRIC GENERATORS. Robert C. Allen (Atomics International, Canoga Park, Calif.). New York, Society of Automotive Engineers, Inc., 1964, Preprint 883C, 5p. $1.00. (CONF-610-1)

From Society of Automotive Engineers, Inc. Summer Meeting, Chicago, June 1964.

A design for portable generators with power outputs of 5 to 100 w is discussed, using a 75-w unit as an example. The generators, which can operate with gaseous, liquid, or

solid fuels, feature a high power-to-weight ratio due to a liquid-cooled heat exchanger. (D.C.W.)

34504 IMPROVEMENTS IN THERMIONIC CONVERTERS. (to Commissariat à l'Energie Atomique). British Patent 966,130. Aug. 6, 1964. Priority date Mar. 5, 1962, France.

A thermionic converter is designed which gives a high voltage (2.5 v), a high power-to-weight ratio, and can utilize various heat sources at relatively low temperatures on the order of 1000°C. The converter uses a cesium atmosphere and a cathode arrangement which includes, in addition to the usual heated cathode, a fine wire or wires forming a grid with a higher output potential than the cathode. During operation of the converter, the wire or grid is heated to a higher temperature than the cathode. The cathode may be Pt or Ni coated with alkaline-earth oxides, while the wires may consist of tungsten. The anode may be covered with a layer of graphite. Several embodiments of the converter are described for generating direct and alternating current. (D.L.C.)

34505 GENERATION OF POWER USING EMISSIVE MATERIALS. Courtland M. Henderson and Robert G. Ault (Monsanto Co.). U. S. Patent 3,139,541. June 30, 1964. Filed Nov. 20, 1961.

Electrodes for thermionic devices are described that possess high thermal and electric conductivities, stable and high electron emissivities over a wide temperature range, and resistance to sagging and corrosion at high temperatures. The electrodes are made of a metal matrix of Ni, Fe, Co, W, Mo, Nb, Ta, Cu, Cr, V, Ag, Au, Pt, or Ir with an internally dispersed refractory such as an oxide of Ce, Nd, Pr, La, or Th. (R.E.U.)

Elementary Particles and Radiations

34506 (BNL-8094) STUDY OF SOME EXPERIMENTAL DATA ON K-MESON DECAYS. Ian J. McGee (Brookhaven National Lab., Upton, N. Y.). July 23, 1963. Contract [AT(30-2)-Gen-16]. 9p.

An analysis of partial decay rates, based on previous experimental data, is presented for mesons K_2^0 and K^+. The validity of the $\Delta I = 1/2$, $\Delta I = 1/2$ (leptonic), and CP-invariance laws is considered. (R.E.U.)

34507 (JINR-E-1686) RELATIVISTIC CORRECTIONS TO s AND p WAVES OF PION-NUCLEON SCATTERING. P. S. Isaev, V. A. Meshcheryakov, G. M. Radutskii, and A. N. Tabachenko (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 9p.

The relativistic corrections to the s-wave of meson(π)-nucleon scattering are calculated. A comparison is made with the nonrelativistic calculation. It is shown that: (a) the account of pion-pion interaction is necessary to describe correctly the energy behavior of the s-wave phase shift of meson(π)-nucleon scattering, (b) in the considered method of calculation the relativistic corrections are small and, (c) there is a reliable possibility to determine the meson(π)-meson(π) interaction and find its parameters (scattering wave length and the resonance position). For this a more exact experimental measurement of the small phase shifts of meson(π)-nucleon scattering is needed. (auth)

34508 (JINR-P-1674) UPRUGOE RASSEYANIE PROTONOV NA PROTONAKH PRI ENERGII 8.3 Gev. (Elastic p-p Scattering at 8.3 Gev). L. F. Kirillova, V. A. Nikitin, and M. G. Shafranova (Joint Inst. for Nuclear Research Inst., Dubna, U.S.S.R. Lab. of High Energy). 1964. 6p.

Elastic p-p scattering at 8.3 Bev was studied by means of water-filled emulsion stacks; 749 events were identified. The data indicate either the real part of the scattering amplitude (in this case constructive interference between the Coulomb and nuclear scattering amplitudes takes place), or the difference between the nuclear amplitudes in the two spin states of the nucleons. The total elastic cross section was found to be (11.2 ± 0.7) mb. (auth)

34509 (NP-14086) ETUDE THEORIQUE DE LA PRODUCTION DE PARTICULES SECONDAIRES DANS LES INTERACTIONS DE PARTICULES ELEMENTAIRES (these). (Theoretical Study of the Production of Secondary Particles in the Interactions of Elementary Particles (thesis)). Roger Laverriere (Lyon. Université). [1963]. 122p.

High-energy elementary particle interactions are considered. Experimental data together with strange-interaction theory are used to investigate interaction processes. Meson(π)-nucleon interactions are divided into central and peripheral collisions. Fermi statistics are used to analyze central collisions, and phase-space integrals are obtained from an approximation method. Satisfactory results are obtained for the mean number of mesons(π) emitted and the relative production of strange particles. Meson exchange graphs are used to analyze peripheral collisions. Nucleon production is shown to proceed by way of a spin-$3/2$ resonance. The ratio of nucleon production by intermediate isobar to direct production is calculated, and the total angular distribution of nucleons is determined. The excitation function for the π-π interaction is evaluated. Associated production of strange particles is shown to be explained by meson(K)-exchange graphs. (J.S.R.)

34510 (NP-14146) AN SU_3 MODEL FOR STRONG INTERACTION SYMMETRY AND ITS BREAKING. [PART] II. G. Zweig (European Organization for Nuclear Research, Geneva). Feb. 21, 1964. 80p.

Both mesons and baryons are constructed from a set of three fundamental particles called aces. The aces break into an isospin doublet and singlet. Each ace carries baryon number $1/3$ and is fractionally charged. SU_3 ,but not the Eightfold Way) is adopted as a higher symmetry for the strong interactions. The breaking of this symmetry is assumed to be universal, being due to mass differences among the aces. Extensive space-time and group theoretic structure is then predicted for both mesons and baryons, in agreement with existing experimental information. Quantitative speculations are presented concerning resonances that have not as yet been definitively classified into representations of SU_3. A weak interaction theory based on right- and left-handed aces is used to predict rates for $|\Delta S| = 1$ baryon leptonic decays. An experimental search for the aces is suggested. (auth)

34511 (NYO-2584-1) FINAL REPORT [ON REACTIONS PRODUCED WHEN ANTIPROTONS ANNIHILATE ON PROTONS]. Joseph Shapiro (Fordham Univ., New York). [1963]. Contract AT(30-1)-2584. 7p.

A theoretical study of the relative probabilities for the production of various final states in $p-\bar{p}$ annihilation at 3 to 9.14 Bev/c is discussed. The investigation makes use of the covariant formulation of the statistical model for nuclear reactions. Resonances are ignored. Results are qualitatively summarized. (T.F.H.)

34512 (UCRL-11140) PION-NUCLEON SCATTERING AT 310 Mev: NEUTRON POLARIZATION IN $\pi^- + p \rightarrow \pi^0 + n$ AND PHASE-SHIFT ANALYSIS (thesis). Roger Eugene Hill (California. Univ., Berkeley. Lawrence Radiation Lab.). June 26, 1964. Contract W-7405-eng-48. 104p.

The recoil neutron polarization in π^--p charge-exchanger scattering at an incident pion kinetic energy (lab) of 310 Mev and at a pion center-of-mass scattering angle of 30 deg was measured. The polarization was obtained from measurements of the left-right asymmetries in the scattering of the neutrons from liquid helium at lab scattering angles of 125 and 75 deg. The measured polarization was $+0.24 \pm 0.07$, where the + sign indicates a direction parallel to $\vec{k}_{in} \times \vec{k}_{out}$. This is opposite in sign to the prediction of the only SPD phase-shift solution and of the "best" of the three SPDF phase-shift solutions arrived at by partial-wave analyses of all the previously available data at or near 310 Mev. The extension of the phase-shift analyses to include this new datum has yielded no SPD solution and only two likely SPDF solutions. Both these solutions have positive $S_{1,1}$ and $P_{1,1}$ phase shifts, and both are of the Fermi type in the I = 3/2 set, though one of them (A) has $(D_{3,3} - D_{3,5}) > 0$, while the other solution (B) has $(D_{3,3} - D_{3,5}) < 0$. The errors on the individual phase shifts range between 0.3 and 1.5 degrees. The π^--p polarization data show a preference for solution A. Partial-wave amplitude dispersion relation calculations are in poor agreement with both A and B, though forward dispersion relation calculations for the real part of the forward non-spin-flip amplitudes show a preference for, and are in excellent agreement with, solution A. (auth)

34513 (UCRL-11428) SEARCH FOR $K^-p \rightarrow \Lambda\mu^+\mu^-$ OR Λe^+e^- AT 2.45 AND 2.7 Bev/c INCIDENT K^-. Angela Barbaro-Galtieri and Robert D. Tripp (California. Univ., Berkeley. Lawrence Radiation Lab.). July 6, 1964. Contract W-7405-eng-48. 11p. (CONF-550-6)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Bubble chamber events were analyzed for possible production of mesons (ω) and mesons (φ), which decay into meson (μ) pairs and electron pairs. Branching ratios were calculated. The experiment produced negative results. (R.E.U.)

34514 (UCRL-11430) PRODUCTION OF $\Xi K(n)\pi$, $\Lambda K\bar{K}(n)\pi$, AND $\Sigma K\bar{K}$ FINAL STATES IN K^--p INTERACTIONS AT 2.45 TO 2.70 Gev/c. Gerald A. Smith, James S. Lindsey, and Joseph J. Murray (California. Univ., Berkeley. Lawrence Radiation Lab.). June 24, 1964. Contract W-7405-eng-48. 14p. (CONF-550-3)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

A 72-inch hydrogen bubble chamber was exposed to a separated beam of K^- mesons at incident momenta of 2.45, 2.55, 2.64, and 2.70 Bev/c. Approximately 475,000 pictures with 6 to 7 K^- and 1 to 2 π^- per picture were taken in the approximate ratio 1 : 1 : 3 : 2 at each of the respective momenta. Scanning and measuring of $\Xi K\pi$, $\Xi K\pi\pi$, $\Lambda K\bar{K}$, $\Lambda K\bar{K}\pi$, and $\Sigma K\bar{K}$ reactions yielded 518, 85, 426, 26, and 31 events, respectively. These numbers represent approximately two-thirds of the total available data. Production of Ξ^*(1530 Mev), ϕ(1020 Mev), and K^*(890 Mev) is observed in these events over this range of momenta. A detailed discussion of the dominant characteristics of these reactions and the possible existence of new strangeness −2 baryon states of mass less than 2 Bev is presented. (auth)

34515 (UCRL-11431) ADDITIONAL PROPERTIES OF THE 959-Mev MESON. George R. Kalbfleisch, Orin I. Dahl, and Alan Rittenberg (California. Univ., Berkeley. Lawrence Radiation Lab.). July 8, 1964. Contract W-7405-eng-48. 12p. (CONF-550-4)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Probable quantum numbers $IJ^{PG} = 00^{-+}$ are assigned to the 959-Mev $\eta 2\pi$ mesons from experiments of K^--p interactions at 2.5 to 2.7 Bev/c. (R.E.U.)

34516 (UCRL-11435) DIFFERENTIAL DISTRIBUTION OF CHARGE-EXCHANGE AND INELASTIC NEUTRONS IN π^--p INTERACTIONS AT 313 AND 371 Mev (thesis). Don Leslie Lind (California. Univ., Berkeley. Lawrence Radiation Lab.). July 1, 1964. Contract W-7405-eng-48. 72p.

Neutron distributions from the charge-exchange (π^0n) and inelastic modes ($\pi^0\pi^0$n, $\pi^+\pi^-$n) of the π^--p interaction were investigated at 313 and 371 Mev. The pion beam of the Berkeley 184-inch synchrocyclotron was focused on a liquid hydrogen target. The scattered neutrons were detected in blocks of plastic scintillator surrounded by anti-coincidence counters. Their time-of-flight distribution is determined electronically. Elastic and inelastic neutrons are separated in the all-neutral final states by this time-of-flight information. The charge-exchange differential cross section is least-squares fit with a Legendre expansion. The charged-mode inelastic-neutron ($\pi^+\pi^-$n) distribution has a marked enhancement at the lowest cms neutron energies (highest two-pion kinetic energy). There is no clear evidence of an ABC effect. The neutral mode ($\pi^0\pi^0$n) distribution is inconclusive. (auth)

34517 (UCRL-11436) Ξ^* (1530-Mev) SPIN AND PARITY. Janice Button-Shafer, James S. Lindsey, and Gerald A. Smith (California. Univ., Berkeley. Lawrence Radiation Lab.). July 3, 1964. Contract W-7405-eng-48. 5p. (CONF-550-5)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

The T = ½ Ξ-π resonance at 1530 Mev was analyzed for K^--p interactions at 2.45, 2.6, and 2.7 Bev/c in a 72-inch bubble chamber. Three- and four-body events were identified. The Ξ^* decay was analyzed using the method proposed by Byers and Fenster. (R.E.U.)

34518 (UCRL-11546) ON THE EXTENSION OF THE NON-RELATIVISTIC THREE-BODY SCATTERING AMPLITUDE TO COMPLEX VALUES OF THE TOTAL ANGULAR MOMENTUM. Roland Omnes (California. Univ., Berkeley. Lawrence Radiation Lab.). June 15, 1964. Contract W-7405-eng-48. 8p. (CONF-550-7)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Difficulties associated with attempts to extend the Regge analysis to the three-body problem are analyzed. Kinematics, collision matrix, and the introduction of a complex total angular momentum are considered. (R.E.U.)

34519 (UCRL-11549) AN ANALYSIS OF K^+_{e4} DECAYS. Robert W. Birge, Robert P. Ely (California. Univ., Berkeley. Lawrence Radiation Lab.); U. Camerini, et al. (Wisconsin. Univ., Madison). June 1964. Contract W-7405-eng-48. 9p. (CONF-550-8)

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

The four-body decays $K^+ \rightarrow \pi^+ + \pi^- + e^+ + \nu$ and $K^+ \rightarrow \pi^+ + \pi^+ + e^- + \bar{\nu}$ were studied in a light-freon chamber. The violation of the $\Delta S = \Delta Q$ selection rule and the π-π interaction were studied. (R.E.U.)

34520 ON THE QUASI-ELASTIC CHARACTER OF INELASTIC TWO-PRONG π^--p INTERACTIONS AT 7 AND 16

Gev/c. G. Bozóki, E. Fenyves, A. Frenkel, and Éva Gombosi (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung., 16: 355-60(1964).

The quasi-elastic diffraction character of inelastic two-prong $\pi^- - p$ interactions was confirmed by investigating the distribution of the four-momentum transfer t. From the similarity of the t distribution obtained for the secondary π^--mesons with the t distribution in $\pi^- - p$ elastic scattering, it was concluded that the incident pion undergoes quasi-elastic scattering and has a tendency to maintain its charge. (auth)

34521 MAJORIZATION OF FEYNMAN DIAGRAMS INVOLVING PIONS AND NUCLEONS. J. B. Boyling (Cambridge Univ., Eng.). Ann. Phys. (N. Y), 28: 435-65 (July 1964).

A method used previously for the majorization of Feynman diagrams involving scalar mesons and conserved baryons is adapted to the case in which the mesons are pseudoscalar. The Symanzik regions for certain production amplitudes are found, and some support properties are proved for the weight functions in Nakanishi's integral representations for scattering and one-particle-production amplitudes. (auth)

34522 ON THE EQUIVALENCE OF ELEMENTARY AND COMPOSITE PARTICLES. B. W. Lee, K. T. Mahanthappa, I. S. Gerstein, and M. L. Whippman (Univ. of Pennsylvania, Philadelphia). Ann. Phys. (N. Y.), 28: 466-77(July 1964).

Equivalence between composite particles, defined as the zeros of the D-function of the N/D method, and elementary particles with vanishing wave function renormalization constants was proved in an approximation retaining only two-particle intermediate states. A precise formulation of the N/D method is presented to facilitate the comparison with field theory. The vanishing of the wave function renormalization constant is formulated in terms of the Lehmann representation. The properties of the proper vertex part are studied in order to establish the equivalence of the above two procedures. (auth)

34523 NONLINEAR PLASMA OSCILLATIONS. W. E. Drummond and D. Pines (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Ann. Phys. (N. Y.), 28: 478-99(July 1964).

The nonlinear limiting of unstable plasma waves is developed by expansion in powers of the field energy. The lowest-order, nonlinear terms lead to a diffusion of the background distribution. This, in turn, reduces the growth rate of the instability, and a stationary "equilibrium spectrum" results. The corrections to the lowest-order theory are calculated in detail, and it is shown that these "mode coupling" terms are negligible except for very long times, for which they lead to a slow decay of the equilibrium spectrum. (auth)

34524 COMPLEX SINGULARITIES IN PRODUCTION AMPLITUDES. J. Cunningham (University Coll. of North Wales, Bangor, U. K.). Australian J. Phys., 17: 161-4 (June 1964).

Complex singularities in the $\pi - N \rightarrow \pi - \pi - N$ amplitude corresponding to vertex contradictions of the single-loop Feynman diagram are shown to exist on the physical sheet of the amplitude, irrespective of whether the theory is formulated in terms of time-ordered or retarded products. (auth)

34525 ON AN APPROXIMATE SECOND-ORDER FERMION DENSITY MATRIX. ADDENDUM. S. Pruski (Nicholas Copernicus Univ., Torun, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys., 12: 227-9(1964).

A condition is formulated under which a relation previously developed in an analysis (NSA 18: 10900) of the second-order density matrix holds. (D.C.W.)

34526 POLARIZABILITY IN NUCLEAR PHYSICS AND IN THE PHYSICS OF ELEMENTARY PARTICLES. Petr Pajas (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Rez). Cesk. Casopis Fys., 14: 132-50(1964). (In Czech)

A survey of the application of the theory of polarizability in connection with a study of the structure of the atomic nucleus and the electromagnetic structure of nucleons is given, together with a survey of the experimental estimates of the electric and magnetic polarizability of the proton and neutron. The possibility of the existence of electron polarizability is also discussed. (auth)

34527 SINGULAR NEUTRINO AND ELECTRON FIELDS. Francoise Moret-Bailly (Faculte des Sciences, Dijon, France). Compt. Rend., 258: 6073-6(June 22, 1964). (In French)

An algebraic study is made of the magnitudes associated with a field of I-spinors describing the electron or neutrino. (tr-auth)

34528 VALIDITY OF THE PHASE SHIFT CALCULATION OF ELECTRON SCATTERING BY BRYSK METHOD. D. M. Bhattacharya and N. C. Sil (Indian Assn. for the Cultivation of Science, Calcutta). Indian J. Phys., 38: 53-4 (Jan. 1964).

Phase shifts for electron elastic scattering on a screened Coulomb potential at 5, 13.5, and 121.8 ev were calculated by the Brysk method and compared with values obtained by the Born approximation and with exact values obtained by a numerical method. (D.C.W.)

34529 FINITE AND DISCONNECTED SUBGROUPS OF SU_3 AND THEIR APPLICATION TO THE ELEMENTARY-PARTICLE SPECTRUM. W. M. Fairbairn, T. Fulton, and W. H. Klink (Johns Hopkins Univ., Baltimore). J. Math. Phys. (N. Y.), 5: 1038-51(Aug. 1964).

An attempt is made to fit the symmetries of the observed elementary particle spectrum into the structure of finite or disconnected subgroups of SU_3. (auth)

34530 ON PAIS'S CHARGE CORRELATION COEFFICIENTS. J. M. Shpiz (Bell Telephone Labs., Murray Hill, N. J.). J. Math. Phys. (N. Y.), 5: 1052(Aug. 1964).

An alternative proof of a theorem of Pais which states that the charge correlation coefficients for an n meson (π) system are independent of the row of the representation of the symmetric group is presented in which no detailed knowledge of the representations is used. (auth)

34531 RENORMALIZATION OF SINGLET AMPLITUDE IN INTERMEDIATE-VECTOR-BOSON THEORY OF WEAK INTERACTIONS. M. Bolsterli (Univ. of Minnesota, Minneapolis and Los Alamos Scientific Lab., N. Mex.). J. Math. Phys. (N. Y.), 5: 1053-4(Aug. 1964). (LADC-6196)

A simple prescription for renormalizing the singlet amplitude in the intermediate-vector-boron theory of weak interactions is given. (auth)

34532 MANY-CHANNEL BARGMANN POTENTIALS. Joseph R. Cox (Univ. of Miami, Coral Gables, Fla.). J. Math. Phys. (N. Y.), 5: 1065-9(Aug. 1964).

A generalization of the Bargmann potentials to include the case of nonrelativistic s-wave scattering of a particle by a target having a finite number of discrete excited states is presented. This generalization allows the explicit construction of a large class of many-channel S-matrices meromorphic on their energy Riemann surfaces, as well as the explicit construction of the corresponding potential

matrices. A two-channel example is treated in detail. (auth)

34533 A PHENOMENOLOGICAL MODEL OF π^+ MESON-PROTON ELASTIC SCATTERING. J. Reignier (Université Libre, Brussels). Nucl. Phys., 54: 225-41 (May 1964). (In French)

A phenomenological model for π^+-p elastic scattering below 300 Mev is presented, based on the hypothesis that the scattering amplitude is completely determined by one single Regge pole. The model gives a rather satisfactory representation of the angular distribution, especially around the resonance. (auth)

34534 THE $\pi\pi \rightarrow K\bar{K}$ REACTION AND LOW ENERGY P-WAVE πK SCATTERING. A. N. Kamal (Univ. of Liverpool). Nucl. Phys., 54: 242-52(May 1964).

Field models are proposed to explain the π-$\pi \rightarrow$ K-$\bar{K}$ cross-sections in the I = 0 and 1 states, derived from the $\pi^- + p \rightarrow K + K + p$ (or n) experiments. The I = 0 cross-section is explained through the assumption of an elastic K-$\bar{K}$ rescattering in the s-state. It is shown that the assumption that the I = 1 reaction proceeds predominantly through the intermediate meson (ρ) state fits the I = 1 cross-sections. Finally the low-energy, p-wave πK elastic scattering is studied in the framework of a model involving only the ρ and the K*-pole diagrams. (auth)

34535 BREAK-UP OF A DEUTERON BY A NUCLEON. V. V. Komarov and Anna M. Popova (Moscow State Univ.). Nucl. Phys., 54: 278-94(May 1964).

Integral equations for the amplitude of the interaction of three nucleons are obtained by the nonrelativistic graph summation method. The initial graphs corresponding to the initial iterations of these equations are considered. Their contribution is calculated in analytical form. The contribution from the initial graphs is found to correspond accurately to the results obtained by authors for the first approximation of perturbation theory, taking into account the interaction of particles in the final state. Simple analytical formulas are proposed for the angular and energy distributions of the products of the break-up of deuterons by nucleons. All the results obtained are generalized for the case of real nucleons with spins and isobaric spins. (auth)

34536 DISPERSION RELATIONS AND KΛ PHOTOPRODUCTION ON A PROTON. N. F. Nelipa and V. A. Tsarev (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 55: 155-60(June 1964).

An approximate solution is found for the set of integral equations, obtained previously for the multiploles of the $\gamma + p \rightarrow K^+ + \Lambda$ reaction in the energy region near the threshold. The unknown parameters involved in the solution are determined with the aid of experimental data available. (auth)

34537 CORRECTIONS TO THE IMPULSE APPROXIMATION FOR ELASTIC NUCLEON-DEUTERON SCATTERING. N. M. Queen (Univ. of Birmingham, Eng.). Nucl. Phys., 55: 177-96(June 1964).

Corrections to the simple impulse approximation arising from the presence of off-the-energy-shell matrix elements and multiple scattering contributions are studied, using a multiple scattering expansion of the t-matrix. Certain sets of contributions to this expansion are shown to converge, and methods of evaluating these contributions explicitly to all orders of multiple scattering are given. The results are applied to calculations of nucleon-deuteron elastic scattering at 32 and 40 Mev. Large corrections are found to previous calculations by the impulse approximation, resulting in an improved fit to the experimental data. (auth)

34538 SCATTERING OF LOW-ENERGY PHOTONS ON A ZERO-SPIN PARTICLE. V. A. Petrunkin (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 55: 197-206(June 1964).

All terms quadratic in the frequency in the expansion of the scattering amplitude for a photon scattered on a spin-zero particle are considered in terms of local field theory. It is shown that their description requires two additional parameters $\bar{\alpha} = \alpha + \Delta\alpha$ and $\bar{\beta} = \beta + \Delta\beta$, together with charge and mass (α and β are the electrical and magnetic polarizability coefficients and $\Delta\alpha$ and $\Delta\beta$ are the corrections connected with the form factor of the particle charge). A similar result is obtained when considering the scattering of a photon on a bound system described by the non-relativistic equation. The possibility is discussed of determining experimentally the upper limit of the electric polarizability of the neutron α_n in scattering of a photon on helium. (auth)

34539 MESON RESONANCES AND NUCLEON-NUCLEON POTENTIALS. David Y. Wong (NORDITA, Copenhagen). Nucl. Phys., 55: 212-24(June 1964).

A general expression is derived for nucleon-nucleon potentials in the two-body Schrödinger equation, such that the first Born approximation for the scattering amplitudes is identical to relativistic single-particle exchange amplitudes. The potentials so derived are necessarily non-local as well as velocity-dependent. The non-locality is confined to within a nucleon Compton wave length while the velocity dependence is contained in polynomials whose forms depend on the spin of the particle exchanged. For the exchange of pseudoscalar, scalar, and vector mesons, the potentials are calculated explicitly. Comparison of solutions of the Schrödinger equation using such potentials and solutions of relativistic dispersion relations is expected to give a reasonable estimate of the uncertainty of meson-nucleon coupling constants as deduced from nucleon-nucleon scattering data. The present potentials are expected to be substantially different from existing phenomenological potentials because of the non-locality and the velocity dependence, as well as the explicit radial forms. (auth)

34540 A RELATION BETWEEN SELF INTERACTION AND MUTUAL INTERACTION. P. Olesen (Universitet, Copenhagen). Nucl. Phys., 55: 257-64(June 1964).

A theory where mass renormalization is unnecessary is investigated. It is shown that if some rather general conditions are satisfied the theory contains free fields only, or that the S-matrix is equal to one. In other words, the absence of self interaction implies a vanishing mutual interaction. It is pointed out that electrodynamical interactions play a special role which may perhaps become important at high energies, in particular for central collisions. It is shown that a self-consistent theory recently proposed by Salam has only free-field solutions. (auth)

34541 NEW TYPES OF CONNECTIONS BETWEEN LOCAL OPERATORS AND THE SCATTERING MATRIX. E. S. Lonskii and Yu. M. Shirokov (Moscow State Univ.). Nucl. Phys., 55: 293-9(June 1964).

The previous method of obtaining the S-matrix from a known two-particle matrix element of an arbitrary local operator is analyzed in detail for the relativistic case. It is shown that the direct application of the techniques makes it possible to obtain all scattering phases, except one, e.g., the s-phase. This method is elaborated so as to make possible the calculation of the s-phase up to a numerical factor. (auth)

34542 π^0 PRODUCTION IN π^-p INTERACTIONS AT 10 Gev/c. T. Siemiarczuk (Inst. of Nuclear Research, Warsaw). Nucl. Phys., 57: 479-82(Aug. 1964).

The average number of mesons (π^0) per interaction and the mean energy and transverse momentum of the mesons (π^0) in six and eight prong events were determined. The angular and momentum distributions of the gamma quanta were analyzed. Information on the same quantities for mesons (π^0) was also obtained. (D.C.W.)

34543 K^+-p SCATTERING. G. Białkowski (Univ of Warsaw), A. Jurewicz, and M. Świecki. Nucl. Phys., 57: 493-8(Aug. 1964).

Starting from a simple model, the K^+-p differential and total cross sections in the region up to 450 Mev kinetic energy of the meson (K) in the laboratory system were calculated. The results are in good agreement with the experimental data. (auth)

34544 THE PRODUCTION OF He^3 FROM DEUTERON INTERACTIONS AT 650 Mev. K. R. Chapman (Univ. of Birmingham, Eng.), J. D. Jafar, G. Martelli, et al. Nucl. Phys., 57: 499-508(Aug. 1964).

The angular distributions of He^3 particles produced in association with one pion in the interaction of 650-Mev deuterons with protons and with individual nucleons from deuterium target nuclei were measured in the forward direction. The differential cross sections at 0° in the center-of-mass system were found to be 11.6 ± 0.5 and $(18.7 \pm 1)\ \mu b \cdot sr^{-1}$, respectively. The interaction of deuterons with deuterons producing He^3 particles and neutrons was also investigated and at 0° yields a cross section of $78 \pm 5\ \mu b \cdot sr^{-1}$ in the center-of-mass system. (auth)

34545 THE RENORMALIZABLE ELECTROMAGNETIC INTERACTIONS OF CHARGED VECTOR MESONS. L. M. Nath (Univ. of Edinburgh). Nucl. Phys., 57: 611-23(Aug. 1964).

A method is presented for describing a charged vector meson with arbitrary magnetic moment in interaction with the electromagnetic field. The renormalizability of the theory is discussed by using the "ξ limiting process" of Lee and Yang. It is shown that the approach has some advantages over the conventional formalism—certain interaction terms which are non-renormalizable in the latter become renormalizable in this scheme. (auth)

34546 SEPARABLE NON-LOCAL NUCLEAR POTENTIAL FOR SINGLET STATES. J. H. Naqvi (Aligarh Muslim Univ., India). Nucl. Phys., 58: 289-98(Sept. 1964).

Singlet state phase shifts for N–N scattering are calculated using a separable non-local nuclear potential. The over-all agreement between the calculated phase shifts and the phase shifts obtained by the Yale Group (the set YLAM for T = 1 and YLAN3M for T = 0 states) is very good, except for the l = 1 state. For the 1p state the calculated phase shifts at energies above about 250 Mev are numerically a little smaller than the corresponding YLAN3M parameters. (auth)

34547 EQUIVALENCE OF MANIFESTLY COVARIANT THEORIES FOR SPIN ½. A. D. Bryden (Glasgow Univ.). Nucl. Phys., 58: 314-20(Sept. 1964).

The transformations from the Bargmann-Wigner equations to the Proca equations for spin 1 and from the Bargmann-Wigner equations to the Rarita-Schwinger equations for spin ½ are presented. The scalar products are shown to be invariant under these transformations. Relations among manifestly covariant wave functions are also derived. (auth)

34548 THE MAXIMUM VALUE FOR THE PION-NUCLEON COUPLING CONSTANT. Yasusi Ataka (Universiteit, Vienna). Nucl. Phys., 58: 348-52(Sept. 1964).

The maximum value for the π–N coupling constant is calculated from the Lehmann-Symanzik-Zimmermann condition on the π-N vertex function. The ladder approximation solution for the vertex function obtained by Federbush, Goldberger and Treiman is used. (auth)

34549 LIFETIME OF QUASI PARTICLES IN FERMI SYSTEM. R. D. Mattuck (Universitet, Copenhagen). Phys. Letters, 11: 29-31(July 1, 1964).

The existence of quasiparticles in normal Fermi systems is discussed in terms of the particle lifetime, which becomes infinite at the Fermi surface. The single-particle propagator is calculated, and its quasiparticle component is examined. An abbreviated version of Luttinger's proof of the existence of the Fermi surface is obtained. (R.E.U.)

34550 POLARISATION OF 40 Mev PROTONS ELASTICALLY SCATTERED FROM DEUTERONS. H. E. Conzett, H. S. Goldberg, E. Shield, R. J. Slobodrian, and S. Yamabe (Univ. of California, Berkeley). Phys. Letters, 11: 68-70(July 1, 1964). (UCRL-11415)

The polarization of protons elastically scattered by deuterons at 20 to 114° (lab) was studied using a polarized 40-Mev proton beam. (R.E.U.)

34551 THE MAGNITUDE OF THE INDUCED PSEUDOSCALAR TERM IN MUON CAPTURE. J. C. Taylor (Cambridge Univ., Eng.). Phys. Letters, 11: 77-8(July 1, 1964).

The magnitude of corrections due to exchanges of higher mass states in the exchange of a single virtual meson (π) in meson (μ) capture, which results in an effective pseudoscalar coupling of strength $g_p \cong 7g_A$ where g_A is the axial vector nucleon-lepton coupling constant, is estimated. (R.E.U.)

34552 RESULTS OF A SEARCH FOR π^+-π^- RESONANCE IN THE DIPION MASS REGION 280-350 Mev. I. M. Blair, G. Conforto, C. Rubbia, G. Torelli, and E. Zavattini (CERN, Geneva). Phys. Letters, 11: 79-82(July 1, 1964).

An experiment is described for investigating the effects of the π-π final-state interaction in $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ at 285 Mev. The ($^3/_2$, $^3/_2$) meson (π)-nucleon resonance was eliminated by event selection. Triggered spark chamber photographs were used in the analysis. The existence of the ω_{ABC} (O^{++}) resonance is included. (R.E.U.)

34553 BARYON RESONANCES IN W_3 SYMMETRY. S. L. Glashow and D. J. Kleitman (Harvard Univ., Cambridge, Mass.). Phys. Letters, 11: 84-6(July 1, 1964).

The description of $j = {}^3/_2{}^+$ meson–baryon resonances in terms of W_3 symmetry is discussed. Symmetry breaking is considered, and it is concluded that W_3 is compatible with the observed patterns of resonances. (R.E.U.)

34554 A 45-FOLD $^3/_2{}^+$ BARYON MULTIPLET? W. Alles (CERN, Geneva). Phys. Letters, 11: 86-7 (July 1, 1964).

An extension of SU_3 proposed by Schwinger, the $U_3 \otimes U_3$ group, in which two fundamental triplets of baryon numbers 1 and 2 exist, is discussed in terms of charge and hypercharge content. It is shown that once the charge content of the fundamental triplets is chosen, the choice of the pseudoscalar mesons is fixed by the condition of nonzero πN coupling and $U_3 \otimes$ U3 invariance of the meson–baryon interaction. (R.E.U.)

34555 ON THE INFLUENCE OF THE DEUTERON MODEL ON INELASTIC ELECTRON-DEUTERON-CROSS-SECTION. K. Hoelzl and P. Urban (Universität, Graz). Phys. Letters, 11: 88(July 1, 1964).

The deuteron wave function dependence of the cross section for inelastic electron-deuteron scattering near the quasielastic peak is discussed. (R.E.U.)

34556 THE BARYON OCTET-$\frac{3}{2}^+$ DECUPLET RECIPROCAL BOOTSTRAP AND THE MAGNETIC MOMENTS OF THE BARYONS. R. F. Dashen (California Inst. of Tech., Pasadena). Phys. Letters, 11: 89-91(July 1, 1964).

The status of the reciprocal bootstrap of Chew in SU(3) is clarified, and it is shown that the reciprocal bootstrap mechanism suggests that the D to F ratio for the pseudoscalar meson couplings is the same as the D to F ratio of the baryon magnetic moments. Pseudoscalar meson-baryon scattering in the limit of perfect unitary symmetry was used to investigate the possibility of a reciprocal bootstrap relation between the octet of $\frac{1}{2}^+$ baryons and the decuplet of $\frac{3}{2}^+$ isobars. The N/D method in the effective range approximation is used to calculate the $\frac{3}{2}^+$ isobar width and baryon-meson coupling constant. (R.E.U.)

34557 BOOTSTRAPPING OF VECTOR MESONS? K. Dietz and G. Domokos (CERN, Geneva). Phys. Letters, 11: 91-3(July 1, 1964).

The exchange of a vector meson multiplet between spinless particles is considered, assuming the existence of a symmetry group, by investigating the manifold of the solutions of the system of integral equations for the matrix functions N and D. It is concluded that the possibility of generating vector mesons in a N/D calculation depends critically on the knowledge of the distant singularities. (R.E.U.)

34558 FERMION REGGE TRAJECTORIES IN PERTURBATION THEORY. J. C. Polkinghorne (Cambridge Univ., Eng.). Phys. Letters, 11: 93-4(July 1, 1964).

The appearance of the $(i\gamma p - m)$ factor in the first two terms in the expansion of the Regge contribution associated with $l = -1$ trajectories associated with a nucleon of mass m in interaction with a pseudoscalar meson of mass μ is discussed. This implies that the trajectory of opposite parity to the nucleon passes through $l = -1$ when $s = m^2$. (R.E.U.)

34559 STUDY OF THE PERTURBATION SERIES FOR THE GROUND STATE OF A MANY-FERMION SYSTEM. PART II. George A. Baker, Jr., B. J. Hill, and Robert J. McKee, Jr. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 135: A922-31(Aug. 17, 1964). (LADC-6314)

The many-fermion perturbation series is derived through fourth order in the potential strength for a velocity-dependent force which exactly simulates, in two-body scattering, a hard core. The Padé approximate method to sum the complete series and the ladder and Brueckner approximation series are used. These results are compared with those of the K-matrix procedure and find that the K-matrix procedure fails to converge for the Brueckner approximation in the only interesting region. A system something like ^{3}He is investigated near saturation. It is found that there is not, as some have speculated, a magic cancellation that would cause the ring diagrams to be of little importance there. (auth)

34560 UNITARITY BOUNDS OF THE SCATTERING AMPLITUDE AND THE DIFFRACTION PEAK. S. W. MacDowell and A. Martin (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 135: B960-62(Aug. 24, 1964).

From unitarity alone a lower bound for the derivative of the absorptive part of the forward scattering amplitude with respect to the momentum transfer is obtained, in terms of the elastic and total cross sections. Comparison with high-energy scattering experiments shows that the actual value of this derivative is rather close to the lower bound, which provides some information on the partial-wave distribution. The result can also be used to obtain consistency requirements on theoretical models. If Regge behavior is assumed for high-energy scattering, namely, $F(s,t) \simeq f(t)s^{\alpha(t)}$, then it can be shown that either $\alpha'(0) \geq \epsilon > 0$ or $\alpha(t) \equiv$ const. (auth)

34561 TESTS OF THE CONSERVED VECTOR CURRENT AND PARTIALLY CONSERVED AXIAL-VECTOR CURRENT HYPOTHESES IN HIGH-ENERGY NEUTRINO REACTIONS. Stephen L. Adler (Princeton Univ., N. J.). Phys. Rev., 135: B963-6(Aug. 24, 1964).

Consider the high-energy neutrino reaction $\nu + \alpha \rightarrow l + \beta$, with α a nucleon or nucleus, l a lepton (e or μ) and β a system of strongly interacting particles. Suppose that the mass of α and the invariant mass of β are not equal, and that the lepton mass is neglected. Then when the lepton emerges with its momentum parallel to that of the neutrino, the squared matrix element, averaged over lepton spin, depends only on the divergences of the vector and the axial-vector currents. Tests of the conserved vector current and the partially conserved axial-vector current hypotheses, based on the theorem, are proposed. (auth)

34562 APPROXIMATE BOOTSTRAP TECHNIQUE. Arthur W. Martin (Argonne National Lab., Ill.). Phys. Rev., 135: B967-74(Aug. 24, 1964).

A "degenerate kernel" approximation technique is suggested for many-channel bootstrap problems. The approximation method reduces the solution of the matrix ND^{-1} integral equations to algebra and is especially suited for problems with complicated self-consistency constraints. It further avoids the subtraction-point dependence and lack of symmetry of the conventional "determinantal" approximation to the scattering matrix. The method is applied to the single-channel vector-meson bootstrap problem; the self-consistent solutions are discussed. Finally, it is shown that the scattering matrix obtained from the once subtracted matrix ND^{-1} integral-equation formalism is both symmetric and independent of the subtraction point. (auth)

34563 RADIATIVE CORRECTIONS TO π-e SCATTERING. Joseph Kahane (Columbia Univ., New York). Phys. Rev., 135: B975-1004(Aug. 24, 1964).

The radiative corrections to order α^3 for electron-pion scattering were calculated. The inelastic part of the radiative corrections were realistically handled assuming an experimental setup, much like that of Fitch and Leipuner at Brookhaven, where the energies of both final particles are measured. Although large log-squared terms are found in the results, they are always cancelled by comparable terms. The reason for their appearance can be directly related to the nature of the experimental situation. (auth)

34564 "BARRIER-REEF" MODEL OF RESONANCE PARTICLES. R. D. Hill (Univ. of Illinois, Urbana). Phys. Rev., 135: B1005-9(Aug. 24, 1964). (COO-1195-06)

A number of resonance particles are described in terms of a potential-well model of two-particle systems. It is found that the systems may have resonance states in the continuum and may be held back from decaying by a centrifugal barrier reef. The short, calculated, lifetimes are consistent with those observed for the resonance particles. The variation of the potential-well depths with quantum numbers of the resonance particles is also discussed. (auth)

34565 W-MESON DECAYS IN UNITARY SYMMETRY. H. S. Mani and J. C. Nearing (Columbia Univ., New York). Phys. Rev., 135: B1009-11(Aug. 24, 1964).

A simple model for the axial vector current is proposed

and generalized to SU_3. This model, together with the conserved vector current theory, is used to calculate several two-meson decay modes of the W meson. (auth)

34566 SIGMA PHOTOPRODUCTION FROM CH_2. Charles E. Roos (Vanderbilt Univ., Nashville) and V. Z. Peterson. Phys. Rev., 135: B1012-16(Aug. 24, 1964).

Photoproduced sigmas were observed by placing nuclear emulsions within a few mm of a CH_2 target. One dozen in-flight decays (10 Σ's and 2 Λ^0's) were identified. The background which previously prevented useful exposures was sharply reduced by applying a 160 kgauss field along the photon beam. The bulk of the electrons are held in small orbits, while the heavier charged sigmas are relatively unaffected. Both of the sigma decay modes were observed, as well as the charged mode for Λ^0 decay. The sign of the charged-pion sigma decays can not be distinguished. The sigma proton decay can only come from the Σ^+, and this experiment provides the first measurement of the reaction $\gamma - p \rightarrow \Sigma^+ - K^0$. No event was included with less than 10% difference in ionization between primary and secondary. All observed events had at least one track with ionization greater than 2× minimum. With correction for the assumed loss of lighter events, the average cross section for photon energies between 1100 and 1200 Mev and for kaon center of mass angles between 30 and 120° (~60° cm) in $\gamma - p \rightarrow \Sigma^+ - K^0$ is $(4 \pm 2) \times 10^{-31}$ cm^2/sr. (auth)

34567 VECTOR-MESON PRODUCTION IN MESON-BARYON COLLISIONS. Lu Sun Liu (Northwestern Univ., Evanston, Ill.) and Paul Singer. Phys. Rev., 135: B1017-26(Aug. 24, 1964).

A covariant general treatment of the amplitude for isoscalar vector-meson production in pseudoscalar meson-baryon collisions is presented. For the low-energy region, a model is devised by assuming the invariant amplitudes to obey a one-dimensional dispersion relation. The formalism is applied to the reaction $\pi - N \rightarrow$ meson $(\omega) - N$, for which the single-nucleon and the $\pi - N$ cut are taken to dominate the direct channel, while the crossed channels are described by meson (ρ) and nucleon-exchange processes. In the energy range of interest, the $\pi - N$ cut is further approximated by the isospin $\frac{1}{2}$ isobars. In the multipole amplitudes of the resonances, for which a Breit-Wigner formula is assumed, only the lower ω angular momentum is exhibited. The differential and the total cross sections are thus expressed in terms of the coupling constants involved and the resonant partial widths, which are to be determined by comparison with the available experimental data. A satisfactory fit is obtained using only the Born terms. (auth)

34568 DYNAMICS OF Ω^-. S. Rai Choudhury and Lalit Kumar Pande (Univ. of Delhi). Phys. Rev., 135: B1027-30(Aug. 24, 1964).

A dynamical calculation is performed for the Ω^- in the $\Xi - \overline{K} \rightarrow \Xi - \overline{K}$ amplitude, using the N/D method. The forces considered are due to the Σ exchange in the crossed channel, as well as the others arising from the far left-hand cut. The latter are dealt with in the manner of Balázs. It is seen that the Ω^- can be generated self-consistently with a mass equal to about 1540 Mev. (auth)

34569 ANGULAR CORRELATIONS IN PRODUCTION PROCESSES. S. M. Berman and R. J. Oakes (Stanford Univ., Calif.). Phys. Rev., 135: B1034-40(Aug. 24, 1964). (SLAC-Pub-26)

A method is suggested for studying processes in which resonances or unstable particles are produced. The method consists of analyzing the experimental data in terms of all the possible angular correlations among the decay products of the produced particles. The specific correlations that can be present in a number of experimentally feasible processes are explicitly tabulated. The usefulness of this method of analysis is illustrated by showing how the correlations provide extensive tests of various dynamical models of the production process such as one-particle exchanges. (auth)

34570 UNITARY SYMMETRY AND WEAK INTERACTIONS. II. SU(3) TRANSFORMATION PROPERTIES. S. P. Rosen (Purdue Univ., Lafayette, Ind.). Phys. Rev., 135: B1041-4(Aug. 24, 1964).

It is shown that if weak interactions are T-L invariant and satisfy the $\Delta T = \frac{1}{2}$ rule, their SU(3) transformation properties are severely limited. The nonleptonic Hamiltonian must belong to an octet, and the leptonic Hamiltonian is restricted to an octet and decuplet. To prove this result, the matrix elements of certain spin-type operators are expressed in terms of the Casimir operators for SU(3). T-L invariance and the $\Delta T = \frac{1}{2}$ rule impose constraints upon the eigenvalues of these Casimir operators and hence limit weak interactions in the manner described above. The converse of this result is not true; a Hamiltonian belonging to an octet is not necessarily T-L invariant. (auth)

34571 LOW-ENERGY $\overline{K}N$ INTERACTION AND Y_0^* REGGE POLE. S. N. Biswas and S. K. Bose (Tata Inst. of Fundamental Research, Bombay. Phys. Rev., 135: B1045-7(Aug. 24, 1964).

Assuming that the observed $(\Sigma\pi)$ resonance at 1405 Mev is in the $S_{\frac{1}{2}}$ state and treating it as a Regge particle, the low-energy amplitude is calculated using the Khuri representation. The calculated $\overline{K}N$ scattering length is in agreement with the solution II of Humphrey and Ross. (auth)

34572 PREDICTION OF A $\pi\eta$ RESONANCE. J. Schechter and S. Okubo (Univ. of Rochester, N. Y.). Phys. Rev., 135: B1060-4(Aug. 24, 1964). (UR-875-5)

Using the bootstrap approximation of Zachariasen and Zemach, a relatively broad 1^{--} resonance at about 1 Bev in a two-channel $(\pi\eta, \pi\rho)$ calculation is presented. Such a resonance can only belong to the isocuplet representation of SU(3). Tentatively, an identification can be made on this basis with the B meson, and a recently observed peaking in the $\pi\rho$ channel at about 1250 Mev. (auth)

34573 T = 0 PION-PION SCATTERING. J. J. Brehm (Northwestern Univ., Evanston, Ill.). Phys. Rev., 135: B1065-70(Aug. 24, 1964).

The several-channel N/D method for π-π scattering in the variational framework proposed by Kreps is modified to provide for a better controlled procedure of parameter variation. The choice of channels is such that the ghost constraints can be imposed for isospin T = 0 without introducing any parameters other than those specifying the coupling between channels. The crossing relations yield a condition on the T = 0 and T = 2 full amplitudes, which can then be studied by a computer search among the parameters. The s-wave ghost is found to be at $s = -40$. The s-wave scattering lengths are computed, and the s- and d-wave phase shifts are determined. As in the earlier model, the s waves are found to be repulsive, and the T = 0 d wave shows no f^0 resonance. Another choice of trial functions is discussed and illustrated by means of a model of scalar meson scattering. (auth)

34574 THE ϕ-ω MIXING ANGLE. Y. S. Kim, S. Oneda, and J. C. Pati (Univ. of Maryland, College Park). Phys. Rev., 135: B1076-9(Aug. 24, 1964).

Under the assumption of vector meson dominance for the

decays $\pi^0 \rightarrow 2\gamma$, $\omega \rightarrow 3\pi$, and $\phi \rightarrow \rho + \pi$, the ϕ-ω mixing angle was obtained from the observed decay rates for these processes. The mixing angles thus obtained are smaller than the Okubo-Sakurai value derived from the Gell-Mann–Okubo mass formula for the vector-meson octet. The lower mixing angles obtained here correspond to only a small violation (less than 10%) of the mass-square formula. Further possible checks on the mixing angles obtained here, as well as on the hypothesis of ϕ-ω mixing and the vector-meson dominant model, are discussed. (auth)

34575 RECIPROCAL BOOTSTRAP RELATIONSHIP OF THE OCTET BARYON AND THE DECUPLET BARYON. Yasuo Hara (California Inst. of Tech., Pasadena). Phys. Rev., 135: B1079-81(Aug. 24, 1964).

The reciprocal bootstrap relation of the octet of $(1/2)^+$ baryons and the decuplet of $(3/2)^+$ baryons is studied using the static approximation. If the octet baryon is regarded as a B_8B_8 bound state due to octet and decuplet baryon exchange, $\gamma_{10} \approx 7d^2$ and $d/f \approx 2.2$ are obtained, where γ_{10} is the $\overline{B}_{10}B_8B_8$ coupling constant and d and f are the d and f coupling constants of $\overline{B}_8B_8B_8$ coupling. If octet vector meson exchange processes are included and the vector theory (gauge theory) of strong interactions is assumed, $\gamma_{10} < 7d^2$ and $d/f < 2.2$ are obtained. If the decuplet baryon is regarded as a B_8B_8 bound state due to octet baryon exchange, $\gamma_{10} \approx 4d^2$ is obtained for the ratio $d/f = 2.2$. (auth)

34576 SCATTERING SOLUTIONS OF THE BIEDENHARN SYMMETRIC DIRAC-COULOMB HAMILTONIAN. D. M. Fradkin (Ames Lab., Ames, Iowa). Phys. Rev., 135: B1085-6(Aug. 24, 1964). (IS-856)

Scattering solutions are obtained for the Biedenharn hamiltonian which possesses R_4 symmetry. These are alternatively written in the form of an operator times a plane-wave spinor, and in this form are briefly compared with the exact Dirac and Sommerfield-Maue solutions. (auth)

34577 SINGLE-QUANTUM ANNIHILATION OF POSITRONS. W. R. Johnson, D. J. Buss, and C. O. Carroll (Univ. of Notre Dame, Ind.). Phys. Rev., 135: A1232-5 (Aug. 31, 1964). (TID-20245)

Calculations of the cross section for single-quantum annihilation of positrons by K-shell electrons in the Coulomb field of a nucleus are presented. Numerical results are given for nuclear charges Z = 73, 74, 78, 79, 82, and 90 and for energies from threshold to 1.75 Mev. For Z = 82 the numerical results agree well but not in detail with previous results of Jaeger and Hulme, and show that the Born approximation is too large by a factor of nearly 2. (auth)

34578 UNITARY SYMMETRY AND NONLEPTONIC DECAYS. Nicola Cabibbo (Univ. of California, Berkeley). Phys. Rev. Letters, 12: 62-3(Jan. 13, 1964). (UCRL-11122)

A qualitative understanding of the ratio between rates of $K^0 \rightarrow 2\pi$ and $K^+ \rightarrow 2\pi$ is obtained by extending the assumption of SU_3 invariance to nonleptonic processes. It is also required that: nonleptonic processes conserve S′, the strangeness in frame F′, and the Lagrangian for nonleptonic processes behave as a member of an octet for no $S \geq 2$ or $I \geq 3/2$ in the physical frame F. These conditions combined with CP invariance forbid the 2π decay of a K^0. (L.B.S.)

34579 I = 0 PION-PION AMPLITUDE AND σ DI-PION. A. O. Barut and W. S. Au (Univ. of Colorado, Boulder). Phys. Rev. Letters, 13: 165-7(Aug. 3, 1964).

It is shown that the assumed existence of the ABC enhancement, together with the σ dipion (s-wave resonance near 400 Mev) and unitarity, implies that the whole I = 0, π-π amplitude is almost exactly known to over 400 Mev. The whole amplitude represents an entirely s-wave continuous virtual particle; therefore, the entire trajectory can be used whenever the I = 0, 2π system is exchanged. (D.C.W.)

34580 MAGNETIC MOMENT OF THE Λ. Jared A. Anderson and Frank S. Crawford, Jr. (Univ. of California, Berkeley). Phys. Rev. Letters, 13: 167-9(Aug. 3, 1964).

The magnetic moment of the hyperon (Λ) was determined to be -1.39 ± 0.72 nm, using $\Lambda \rightarrow p + \pi^-$ decays from the interaction $\pi^- + p \rightarrow \Lambda + K^0$. (D.C.W.)

34581 KINEMATICAL INTERPRETATION OF THE FIRST π-p[ρ] RESONANCE. Robert T. Deck (Univ. of Michigan, Ann Arbor). Phys. Rev. Letters, 13: 169-73 (Aug. 3, 1964).

The process $\pi^+ + p \rightarrow \pi^+ + p + \rho \rightarrow \pi^+ + p + \pi^+ + \pi^-$ was analyzed, assuming that the interaction associated with the peak observed in the π-ρ spectrum proceeds mainly by peripheral collisions dominated by one-pion exchange. (D.C.W.)

34582 SPIN AND UNITARY SPIN INDEPENDENCE OF STRONG INTERACTIONS. F. Guersey and L. A. Radicati (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 13: 173-5(Aug. 3, 1964).

It is shown that the group SU(4) can be extended to the relativistic domain and that when strangeness is taken into account the group SU(4) becomes enlarged to SU(6), which contains $SU(3) \otimes [SU(2)]_q$ as a subgroup, where $[SU(2)]_q$ is the unitary subgroup of the Lorentz group that leaves the momentum four-vector q invariant. (D.C.W.)

34583 IMPLICATIONS OF SPIN-UNITARY SPIN INDEPENDENCE. A. Pais (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 13: 175-7(Aug. 3, 1964).

The implications of the broken SU(6) symmetry for strong interactions are discussed. (D.C.W.)

34584 STRUCTURE IN THE PION-PROTON TOTAL CROSS SECTION BETWEEN 2.5 AND 5.5 Bev/c. A. Citron, W. Galbraith, T. F. Kycia, B. A. Leontić, R. H. Phillips, and A. Rousset (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 13: 205-8(Aug. 10, 1964).

The total cross sections for $\pi^\pm - p$ interactions at 2.5 to 5.5 Bev/c were measured at momentum intervals of 100 Mev/c with a statistical accuracies of 0.05 and 0.08% for $\pi^- - p$ and $\pi^+ - p$, respectively. The data, together with previous observations, indicate that the structure observed in charge-exchange scattering can be attributed to the combined effect of three resonances at 2.5, 3.24, and 3.77 Bev/c. (D.C.W.)

34585 EXPERIMENTAL TESTS OF UNITARY SYMMETRY IN MESON–BARYON REACTIONS. H. Harari (Soreq Research Establishment, Yavne, Israel) and H. J. Lipkin. Phys. Rev. Letters, 13: 208-12(Aug. 10, 1964).

Some predictions of SU(3) for meson-baryon interactions of the form $m + B \rightarrow m + B$, where m and B are pseudoscalar mesons and baryons belonging to the octet representations of SU(3), are presented, together with the principal results of an analysis of meson-baryon interactions. SU(3) predictions are compared with experimental observations for a wide energy range. (D.C.W.)

34586 "U-SPIN EQUALITIES" AND OCTET SYMMETRY BREAKING. S. Meshkov (National Bureau of Standards, Washington, D. C.), G. A. Snow, and G. B. Yodh. Phys. Rev. Letters, 13: 212-17(Aug. 10, 1964).

The extent to which SU(3) predictions are obeyed for the U-spin equalities for interactions of the form meson + proton → baryon resonance + meson was investigated. Deviations from pure SU(3) symmetry by an order of magnitude were found. The violation can be explained by inclusion of octet symmetry breaking in the scattering amplitudes, provided that additional amplitudes from the (41) and (22) representations are large. The possibility of super resonances was noted. (D.C.W.)

34587 LEPTONIC DECAY OF THE Ω^- PARTICLE. V. De Santis (Northwestern Univ., Evanston, Ill.). Phys. Rev. Letters, 13: 217-20(Aug. 10, 1964).

The leptonic decays of the hyperon (Ω^-) were investigated assuming V-A leptonic interaction. Decay rates and distributions were obtained. (D.C.W.)

34588 FOUR-DIMENSIONAL BARYON SPACE AND QUARKS. Arthur Komar (Yeshiva Univ., New York). Phys. Rev. Letters, 13: 220-1(Aug. 10, 1964).

A possible four-dimensional interpretation of the empirically determined symmetries is indicated. The nonexistence of quarks is simply explained. (D.C.W.)

34589 MASS AND COUPLING CONSTANT FORMULAS IN BROKEN SYMMETRY SCHEMES. Peter G. O. Freund and Yoichiro Nambu (Univ. of Chicago). Phys. Rev. Letters, 13: 221-5(Aug. 10, 1964).

The results of partial current conservation were investigated in the context of symmetries of the type $[SU(3)]^n$. Mass and coupling constant relations were derived by the Goldberger-Freiman method, including some not obtainable by the usual perturbation theory. Calculated coupling constants are compared with experimental values and other predictions. (D.C.W.)

34590 SEARCH FOR CP NONCONSERVATION IN K_2^0 DECAYS. A. Abashian, R. J. Abrams, D. W. Carpenter, G. P. Fisher, B. M. K. Nefkens, and J. H. Smith (Univ. of Illinois, Urbana). Phys. Rev. Letters, 13: 243-6(Aug. 17, 1964).

The decay mode $K_2^0 \rightarrow \pi^+ + \pi^-$, forbidden by CP conservation, was sought in an experiment primarily concerned with $K_{\mu 3}^0$ and K_{e3}^0 decays. Analysis of the observed events gave an upper limit of about 0.2 to 0.3% for the 2π decay mode, placing an upper limit of 5×10^{-4} on CP violation. (D.C.W.)

34591 SIGMA PHOTOPRODUCTION AND DETERMINATION OF THE Σ^+ MAGNETIC MOMENT. A. D. McInturff and C. E. Roos (Vanderbilt Univ., Nashville). Phys. Rev. Letters, 13: 246-8(Aug. 17, 1964).

The interaction $\gamma + p \rightarrow K^0 + \Sigma^+$ was investigated by observing in-flight proton decay of the sigmas in nuclear emulsion exposed to a 1280-Mev bremsstrahlung beam. A lower limit of $6.0 \pm 1.5 \times 10^{-31}$ cm^2/pr was established for a mean photon energy of 1175 Mev. Analysis of the data also indicated a magnetic moment of 4.3 ± 0.9 nm for Σ^+ with a mean interaction polarization of 0.95. (D.C.W.)

34592 DECAY MODES AND PROPERTIES OF THE X^0. M. Goldberg (Syracuse Univ., N. Y.), M. Gundzik, J. Leitner, M. Primer, P. L. Connolly, E. L. Hart, K. W. Lai, G. W. London, N. P. Samios, and S. S. Yamamoto. Phys. Rev. Letters, 13: 249-33(Aug. 17, 1964).

The decay modes and quantum number assignments of the meson(x^0) with strangeness 0, mass 960 Mev, and narrow width were investigated. (D.C.W.)

34593 MAGNITUDE OF THE $K_1^0 - K_2^0$ MASS DIFFERENCE. T. Fujii (Brookhaven National Lab., Upton, N. Y.). J. V. Jovanovich, F. Turkot, and G. T. Zorn. Phys. Rev. Letters, 13: 253-7(Aug. 17, 1964).

The $K_1^0 - K_2^0$ mass difference was determined to be 0.82 ± 0.12 by a spark chamber study of coherent regeneration of mesons(K_1^0) in transmission of a meson(K_2^0) beam through an iron slab as a function of regenerator (iron) thickness. (D.C.W.)

34594 ASYMMETRIC μ-PAIR PHOTOPRODUCTION AT SMALL ANGLES. S. D. Drell (Stanford Univ., Calif.). Phys. Rev. Letters, 13: 257-60(Aug. 17, 1964).

An extremely asymmetric kinematic condition for photoproduction of meson(μ) pairs from hydrogen is discussed for probing electrodynamics and studying photoproduction of vector resonances. The cross sections and corrections are considered, as well as detection of the relevant processes. (D.C.W.)

34595 ANALYSIS OF s-WAVE $\pi\pi$ INTERACTION. Sharashchandra H. Patil (Univ. of California, San Diego, La Jolla). Phys. Rev. Letters, 13: 261-4(Aug. 17, 1964).

The s-wave, $I = 0$, $\pi - \pi$ interaction was analyzed assuming that the $\pi^+ - \pi^-$ interaction for states with $J \geq 1$ is dominated by the meson(ρ), that the meson(f°) is an $I = 0$, $I = 2$ resonance, and that $\pi^+ - \pi^-$ production in $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ is dominated by a single pion exchange. The meson ($K_1 - K_2$) mass difference was satisfactorily explained by including both the meson(σ) and strong s-wave interaction around the meson(ρ) position. The asymmetry in the center-of-mass $\pi^+ - \pi^-$ distribution between the meson(σ) and (ρ) positions was found to be very sensitive to the presence of the meson(σ). (D.C.W.)

34596 NONRENORMALIZATION THEOREM FOR THE STRANGENESS-VIOLATING VECTOR CURRENTS. M. Ademollo and R. Gatto (Università, Florence and Comitato Nazionale per l'Energie Nucleare, Frascati, Italy). Phys. Rev. Letters, 13: 264-6(Aug. 17, 1964).

Assuming that the vector currents and the electromagnetic current belong to the same unitary octet and that the breaking of unitary symmetry is due to a term behaving like the eighth component of an octet, it is proved that to the first order in the symmetry-breaking interaction all the vector coupling constants are not renormalized. (D.C.W.)

34597 A CAUSALITY CONDITION FOR SCHRÖDINGER SCATTERING. P. Stehle (Univ. of Pittsburgh). Physica, 30: 1072-6(June 1964).

The outgoing wave boundary condition for non-relativistic Schrödinger scattering is derived from a causality condition through the introduction of a time-dependent Hamiltonian which corresponds to a realistic description of a scattering experiment. (auth)

34598 NEUTRINOS EVERYWHERE. W. Braunbek. Physik. Bl., 19: 10-16(Jan. 1963). (In German)

The theoretical necessity for the neutrino is discussed, and the experimental demonstration of its existence is given. The antineutrino, e-neutrino, μ-neutrino, and cosmic neutrinos are considered. (J.S.R.)

34599 ON THE PHYSICS OF ELEMENTARY PARTICLES. I. OUTLINE OF HISTORY OF ELEMENTARY PARTICLES. H. Rechenberg (Universität, Munich). Physik. Bl., 19: 104-10(Mar. 1963). (In German)

A brief history of the discovery of elementary particles is terminated by the question of why elementary particles are elementary. It is concluded that there is no fundamental difference between elementary particles and nonelementary particles. (J.S.R.)

34600 A GENERALIZATION OF BREMOND-VALATIN METHOD FOR FOUR-BODY CORRELATION AND ITS APPLICATION TO A CHARGE INDEPENDENT PAIRING

INTERACTION. Munetake Ichimura (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 575-94(Apr. 1964).

The method presented by Brémond and Valatin is generalized which attached four-body correlation to the Bogoliubov transformation. A criterion to determine whether a trial ground state vector has an essential feature of four-body correlation or is like that of the generalized Bogoliubov transformation is obtained. This method is applied to a system with a charge-independent pairing interaction. There appear two different kinds of single quasiparticle excitation energy due to p-n interaction. (auth)

34601 p-p SCATTERING AT 660 Mev. MODIFIED ANALYSIS. Yogiro Hama and Norio Hoshizaki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 609-14(Apr. 1964).

The results of a phase-shift analysis of p-p scattering data at 660 Mev are presented. A previously obtained solution is refined. It is suggested that the effect of the LS interaction in the current potential models be strongly reduced in ^3F states. (auth)

34602 p-p SCATTERING AT 970 Mev. Yogiro Hama and Norio Hoshizaki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 615-22(Apr. 1964).

The results of a phase-shift analysis of p-p scattering at 970 Mev are presented and compared with those obtained for p-p scattering at 660 Mev. Assuming the existence of a solution of the same type found at lower energies, two phase-shift solutions were obtained. Measurements of triple scattering parameters provide a basis for discriminating between the two types of solutions. (D.C.W.)

34603 MASS SPECTRA OF BARYONS, MESONS, AND LEPTONS. Hiroshi Katsumori (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 642-53(Apr. 1964).

The possibility that the Yang-Mills gauge fields associated with the conservation of baryon number, isospin, and strangeness break the hypothetical mass degeneracy was examined, using Nambu's self-consistent method to obtain the mass formulas. It was shown that reasonable sizes of the coupling constants and cutoff moments lead to the observed mass spectra of the stable or metastable baryons and the particles (Λ, Σ, Ξ, π, N, and K). Explanation of the lepton mass spectrum by introduction of a gauge field associated with the conservation of leptonic strangeness or muon number was also attempted. (D.C.W.)

34604 AN ANALYSIS OF THE LOW ENERGY π-N SCATTERING. Masayoshi Kikugawa (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 31: 654-78(Apr. 1964).

The π-N scattering below 500 Mev is investigated. The contributions of the first and second resonances (N*) and (N**), a scalar meson with I = 0 and a vector meson with I = 1, are taken into account. From the analysis of both the I-spin flip and non-flip combinations of phase shifts up to the $D(^5/_2)$ state, the following results are obtained. For the explanation of the I-spin non-flip combination of phase shifts, a scalar meson with I = 0 is required. For the π-N interaction, PV-type coupling must coexist with PS-type. Two sets of coupling constants are found to fit the experiments. The contribution of a vector meson with I = 1 is favorable for the explanation of the I-spin flip combination of phase shifts, but the contribution shows opposite sign to that given by Bowcock. This discrepancy originates mainly from the effects of N** neglected in their analysis. (auth)

34605 N/D FORMALISM FOR SCATTERING AMPLITUDES WITH UNSTABLE PARTICLES. Miwae Yamazaki (Metropolitan Univ., Tokyo), Naohiko Masuda, and Jun Otokozawa. Progr. Theoret. Phys. (Kyoto), 31: 679-97 (Apr. 1964).

The consistent N/D formalism is developed for a two-channel problem including unstable particles (in practice, for π, N and ρ, N channels). In order to obtain a consistent formalism with analytic properties for both variables s and ω (ω is the squared meson (ρ) mass), independent ω variables with adequate small imaginary parts are introduced for each meson (ρ). Analytic continuation in ω' variables is carried out without any ambiguity. The resultant partial-wave amplitudes T_{ij} have the required analytic properties in s and ω variables. The ω channel discontinuity of $T_{12}(s,\omega)$ and $T_{22}(s,\omega,\omega')$, discontinuities of $T_{22}(s,\omega,\omega')$ across the anomalous cuts, etc. are discussed. (auth)

34606 THE GAUGE-INVARIANT THEORY OF NEUTRAL VECTOR MESON IN ANALOGY WITH THAT OF QUANTUM ELECTRODYNAMICS. A. Q. Sarker (Univ. of Birmingham, Eng.). Progr. Theoret. Phys. (Kyoto), 31: 705-10(Apr. 1964).

A formulation of the theory of neutral vector meson fields interacting with spinor field is given in analogy with the gage-invariant theory of quantum electrodynamics, recently proposed by Mandelstam. It is then shown that the two theories coalesce in the limit of vector meson mass tending to zero. (auth)

34607 THE Λ-Λ INTERACTION WITH REPULSIVE CORE. Hisao Ohtsubo (Tokyo Inst. of Tech.). Progr. Theoret. Phys. (Kyoto), 31: 711-13(Apr. 1964).

The strength of the Λ-Λ interaction was investigated, taking into account the repulsive core of the Λ-Λ potential. The results are inconsistent with the global and unitary symmetry models. (D.C.W.)

34608 ON THE ORIGIN OF PSEUDOSCALAR BOSON MASS. Masao Yamada (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 713-15(Apr. 1964).

The fermion-pseudoscalar boson system is considered in which a pseudoscalar meson A has the λA^4 interaction as well as the Yukawa interaction. It is shown by Lehman's method that the λA^4 term is essential for the bose field without bare mass to obtain non-vanishing physical mass. (D.C.W.)

34609 NONLEPTONIC HYPERON DECAYS. Jugoro Iizuka and Yoneji Miyamoto (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 715-16(Apr. 1964).

Nonleptonic hyperon decays are investigated, assuming a current-current type hamiltonian invariant under R_p reflection with baryonic currents of Cabbibo's type. (D.C.W.)

34610 f^0-MESON AND PROTON-PROTON SCATTERING. Noboru Hiroshige, Taketoshi Ino, and Masanori Matsuda (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 31: 719-20(Apr. 1964).

The contribution of the meson (f^0) in p-p scattering was investigated using the one-boson-exchange model. Better agreement with experimental phase shifts below 300 Mev was obtained including meson (f^0) exchange than was achieved with a model considering only the exchange of a meson (π), meson (ρ), meson (ω), and scalar meson. (D.C.W.)

34611 THE EFFECTS OF f^0-MESON ON THE πN SCATTERING. Noboru Hiroshige, Taketoshi Ino, and Masayoshi Kikugawa (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 31: 721-3(Apr. 1964).

The contribution of the meson (f^0) to π-N scattering was investigated within the context of Sawada's one-boson-exchange model. It contributes only to the I-spin, non-flip combination of phase shifts. (D.C.W.)

34612 PARITY DOUBLET HYPOTHESIS OF STRANGE PARTICLES AND VIOLATION OF U(4) SYMMETRY OF STRONG INTERACTIONS. Ken-iti Matumoto and Sho Tanaka (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 723-5(Apr. 1964).

A model of elementary particles and the interaction scheme among them is proposed. The basic elements of baryons and bosons comprise four spinor entities (the isodoublet and parity doublet), which are quite massive and degenerate. The fundamental strong interaction among them satisfies the U(4) symmetry. (D.C.W.)

34613 A COMPOSITE MODEL OF ELEMENTARY PARTICLES IN THE BROKEN U_3 SYMMETRY SCHEME. Ikuo Sogami (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 725-7(Apr. 1964).

A model is proposed in which the baryons, mesons, and their resonances are regarded as composite systems of four fundamental particles with the same rank as the lepton family and from which the octet scheme can be reconstructed. (D.C.W.)

34614 SPIN CORRELATIONS IN THE SCATTERING OF THE NEUTRINO AND THE ANTINEUTRINO BY ELECTRONS. B. K. Kerimov and Yu. I. Romanov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 46: 1912-14 (May 1964). (In Russian)

The $(\epsilon\nu)$ (νe) type neutron–lepton interaction predicted by R. Feynman and M. Gell-Mann is of special interest for studying the interaction of neutrinos and antineutrinos with electrons; if the neutrino is capable of being scattered by electrons, then the recoil electrons must be polarized. Appearance of the spin polarization of the recoil electrons is related to the optical properties of the neutrino. Following up previous studies in this field, the νe- and $\bar{\nu}e$ scattering cross sections of the weak, four-fermion interaction were calculated, taking into account the polarization of the target and recoil electrons. The calculations were carried out within the framework of the four-component Dirac neutrino theory, involving 2 neutrinos and 2 antineutrinos, differing by their right and left polarization. If the target electron is polarized in a direction corresponding to that of the incident neutrino beam, the scattering cross section of the right-polarized neutrinos becomes zero; that of the left-polarized neutrinos is not zero and reaches a maximum value. A similar relationship prevails in the case of the high-energy antineutrinos; in that case the scattering cross section of the left-polarized antineutrinos becomes zero. If the target electrons are polarized in a direction opposite to that of the incident beam, the situation is reversed. Thus, the study of the spin correlations in the case of the scattering of the neutrino, respectively antineutrino, by electrons makes it possible to establish the existence of direct neutrino–electron interactions and to confirm the predictions of the four-component neutrino theory with respect to the spiral character of two neutrinos and two antineutrinos. (TTT)

34615 THE PROBLEM OF THE EXISTENCE OF THE HEAVY, CHARGED LEPTON. E. M. Lipmanov (Volgograd Pedagogic Inst., USSR). Zh. Eksperim. i Teor. Fiz., 46: 1917-18(May 1964). (In Russian)

The possibility that new, heavy leptons might exist in nature, possessing a mass higher than that of K mesons was considered. Experiments with high-energy neutrinos do not exclude the possibility of the existence of the heavy lepton μ^H; further studies may allow statistically to prove or disprove whether this is possible for a mass of $m_l \sim 5$ to $9\ m_\mu$. It is estimated that in that mass range, the pion decay $l \rightarrow \pi + \nu$ is by far the more probable scheme than the lepton decay. It was calculated that $\tau(l \rightarrow \pi + \nu) = 1 \times 10^{-10}$ sec for $m_l = 5\ m_\mu$ and $\tau(l \rightarrow \pi + \nu) = 2.4 \times 10^{-11}$ sec for $m_l = 8\ m_\mu$. Consideration of other decay schemes may decrease the estimated total life time by a factor of 2. It is of interest that H. H. Bingham et al. observed 11 events of the type $\nu_\mu + p \rightarrow n + \pi^+ + \nu_\mu$, amounting to about 8% of all the observed events. This must be considered as the highest number of the probability of the $\nu_\mu + p \rightarrow n + l^+ \rightarrow n + \pi^+ + \nu_\mu$ process under the given experimental conditions. Observation of singular strange particles may also be due to the generation of μ'^+. (TTT)

34616 ELASTIC SCATTERING OF 6.2-Gev PROTONS ON DEUTERONS. Z. M. Zlatanov, Kh. M. Kanazirski, L. D. Mincheva, and L. G. Kristov (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 46: 1964-6(June 1964). (In Russian)

Elastic pd scattering at 6.2 Bev was studied with photographic emulsions impregnated with heavy water. The incident proton beam was perpendicular to the plane of the photographic emulsion. Altogether 267 elastic pd-scattering events and 39 pp-scattering events were found. Differential cross sections at 2 to 9.5° in the cms are presented. The elastic scattering cross section $\sigma_{el} = 12.6 \pm 1.4$ mb. The effective pd-interaction radius $R = (2.0 \pm 0.1) \times 10^{-13}$ cm. (auth)

34617 CATALYSIS OF THE $d + d \rightarrow He^3 + n$ FUSION REACTION BY NEGATIVE MUONS. V. P. Dzhelepov, P. F. Ermolov, Yu. V. Katyshev, V. I. Moskalev, V. V. Fil'chenkov, and M. Friml (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 46: 2042-5(June 1964). (In Russian)

Twenty cases of an hitherto unobserved reaction (2) $d\mu + d \rightarrow {}^3He + n + \mu^-$ are recorded in a diffusion chamber filled with deuterium to a pressure of 7.2 atm. The yield of the reaction (2) relative to that of reaction (1) $d\mu + d \rightarrow t + p + \mu^-$ is 1.2 ± 0.37. Estimations of the relative yields of reactions (3) $d\mu + d \rightarrow p\mu + t$ and (4) $d\mu + d \rightarrow {}^3He\mu + n$ show that with a probability of 90% $w(3)/w(1) < 0.13$ and $w(4)/w(2) < 0.13$. The yield of reaction (1) agrees with data previously obtained. However in the experiments the yields of reactions (1) and (2) exceed by approximately an order of magnitude the values which should be expected on basis of the data on reaction (1) obtained in liquid deuterium. (auth)

34618 OPTICAL THEOREM FOR THE SCATTERING OF PARTICLES WITH ARBITRARY SPINS. P. Vinternits. Zh. Eksperim. i Teor. Fiz., 46: 2108-11(June 1964). (In Russian)

An expression is obtained for the imaginary part of the zero-angle scattering matrix for polarized particles of arbitrary spins. The types of initial polarization which can influence the total cross section are discussed. Nucleon–deuteron scattering is considered as an illustration of the general results. (auth)

34619 THE FOUR-BODY PROBLEM AT LOW ENERGIES. V. V. Komarov and A. M. Popova (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 46: 2112-25(June 1964). (In Russian)

Integral equations for four nucleon interaction amplitudes are derived by summing an infinite series of perturbation theory diagrams under the assumption that only pair forces are important. It is shown that the equations for the amplitudes of reactions, in the final states of which two pairs of interacting particles or three interacting particles are formed, are mutually related. The kernels of these

equations contain the three nucleon interaction amplitude in just the same way as the kernel of the equation for the three nucleon interaction amplitude contains the two nucleon scattering amplitude. For sake of simplicity the equations are deduced for spinless particles. In principle it is not difficult to extend the equations to the case of real particles with a spin; this can be performed by the method applied in the three body problem. (auth)

34620 FERMION REGGE POLES IN PROCESSES INVOLVING VECTONS. V. G. Gorshkov, M. P. Rekalo, and G. V. Frolov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 46: 2132-40(June 1964). (In Russian)

The asymptotic value of the cross section for production of vector mesons by π-mesons and γ-quanta on nucleons at angles near to 180° is obtained. The analysis is based on the Regge pole hypothesis. The relations between the cross sections of various processes involving vector mesons are presented. (auth)

34621 DETERMINATION OF THE PARAMETERS AND PHASE SHIFTS FOR LOW ENERGY πN-SCATTERING. V. F. Pleshakov (Inst. of Mathematics, Academy of Sciences, Siberian SSR). Zh. Eksperim. i Teor. Fiz., 46: 2183-7(June 1964). (In Russian)

The role of Coulomb effects and of the contribution from inelastic processes in calculations of the parameters and phase shifts of low energy πN scattering is analyzed. With the determination of s-wave phase shifts as an example it is demonstrated that the π-mesic atom plays an appreciable role. The primary conclusion drawn is that one can not hope to obtain a high accuracy in theoretically treating the experimental results if Coulomb effects are not taken into account consistently. (auth)

34622 REGGE POLES AND AMPLITUDE PRODUCTION OF VECTOR MESONS. A. V. Berkov, Yu. P. Nikitin, and M. V. Terentev. Zh. Eksperim. i Teor. Fiz., 46: 2202-11(June 1964). (In Russian)

The hypothesis of the presence of moving poles in the angular momentum complex plane is employed for studying the spin structure of the vector meson production amplitude in the $\pi + N \rightarrow N + \omega^0(\rho)$ reaction at high energies. The differential cross section of the reaction, polarization of the vector mesons produced, and also the angular distribution of the decay products from $\omega^0 \rightarrow \pi^0 + \gamma$ are calculated on the assumption that the contribution of a single pole is predominant. Production of vector mesons into a zero angle is considered separately. (auth)

34623 ON A POSSIBLE METHOD FOR DETERMINING THE MAGNETIC MOMENT OF THE Σ^+-HYPERON. V. L. Luboshits and M. I. Podgoretskii (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 46: 2221-6(June 1964). (In Russian)

A method for determining the magnetic moment of the Σ^+-hyperon is proposed which does not require the application of strong magnetic fields. The method is based on depolarization of positively charged particles in condensed media. It is shown that in principle the magnitude of the magnetic moment of the Σ^+ hyperon can be found by analyzing the experimental data on asymmetry in $\Sigma^+ \rightarrow p + \pi^0$ decay in flight and at rest. (auth)

34624 LECTURES ON PHONONS AND EXTERNAL RADIATION. A. Sjoelander (Chalmers Univ. of Tech., Goteborg). p.76-101 of "Phonons and Phonon Interactions." New York, W. A. Benjamin, Inc., 1964.

Electron and neutron scattering are briefly treated, together with photon absorption, emission, and scattering. The van Hove formulation of scattering is emphasized, and the properties of the van Hove correlation functions are examined. Some simple applications are considered. (D.C.W.)

34625 INTERNAL QUANTUM NUMBERS WITHOUT INTERNAL COORDINATES. Dave Pandres, Jr. (Lockheed-California Co., Burbank). 19p. (CONF-452-15)

From American Physical Society, Washington, D. C., Apr. 1964.

It is suggested that stable and unstable particles correspond, respectively, to those unitary and nonunitary irreducible representations of the inhomogeneous Lorentz group which involve only space-time coordinates. It is shown that this explains the one-half spin of all stable fermions and the requirement of quantum numbers such as isospin for the description of a particle. The appropriate higher symmetry scheme is shown to be based upon the group SU(4). (auth)

34626 ρ EXCHANGE MECHANISM IN THE REACTION $\pi^+ + p \rightarrow N_{33}^{*++} + \pi^0$. Maris A. Abolins, D. Duane Carmony, Duong-N-Hoa, Richard L. Lander, Carl Rindfleisch, and Nguyen-huu Xuong (Univ. of California, San Diego, La Jolla). 14p. (CONF-452-37)

From American Physical Society, Washington, D. C., Apr. 1964.

The reaction $\pi^+ + p \rightarrow N_{33}^{*++} + \pi^0$ was investigated in a hydrogen bubble chamber at 3.54 Bev/c. Good agreement was obtained between the angular correlations observed in the decay of the N_{33}^{*++} and the predictions based on a single ρ exchange model, but it is pointed out that the energy dependence of the cross section of the reaction is in strong contradiction with the results derived from a ρ exchange model. (C.E.S.)

34627 MULTIPLE COULOMB SCATTERING IN NUCLEAR EMULSIONS FOR VERY LARGE CELL LENGTHS. P. K. Aditya (Indian Inst. of Tech., New Delhi). 11p. (CONF-216-6)

From International Conference on Elementary Particles, Sienna, Italy, Sept.-Oct. 1963.

The mean square value of lateral displacement for 27-Bev protons and 8-Bev mesons (μ) were used to determine the scattering parameter in nuclear emulsions. The general theory of multiple scattering to correlate the lateral displacement with the chord angle method. Spurious scattering was eliminated by subtraction of the distortion contour. The scattering constants for cell lengths from 3 to 10 cm were found to be $K_p = 27.6 \pm 1.3$, and $K_\mu = 31.5 \pm 1.7$. K was found to remain constant in the region 3 to 10 cm. The difference between K_p and K_μ is understood in terms of the presence of inelastic events leading to removal of large-angle scatters and, hence, to a narrower scatter frequency distribution for interacting particles. (auth)

34628 ON THE STATISTICS OF PIONS. H. C. von Baeyer (Vanderbilt Univ., Nashville). 4p. (CONF-452-20)

From American Physical Society, Washington, D. C., Apr. 1964.

Selection rules for nonleptonic decays of mesons (K^0) are given under different assumptions about the statistics of mesons (π). Since the process $K_2^0 \rightarrow \pi^+ + \pi^-$ is forbidden by CP conservation only if mesons (π) are bosons, the existence of a long-lived K^0 particle proves that mesons (π) obey Bose statistics. A further test of meson (π) statistics is suggested. (D.C.W.)

34629 PHOTODISINTEGRATION OF CALCIUM. J. E. E. Baglin. 8p. (CONF-452-26)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

The method of least structures was used to analyze the giant resonance in $^{40}Ca(\gamma,n)$, and results are compared with experimental data from numerous sources. (R.E.U.)

34630 THE T = 2 PION-PION INTERACTION. D. Duane Carmony, Duong N. Hoa, Richard L. Lander, Philip M. Yager, and Nguyen-huu Xuong (Univ. of California, San Diego, La Jolla). 10p. (CONF-452-38)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

Two-prong events in a hydrogen bubble chamber from 3.5-Bev/c π^+-mesons were analyzed. The existence of a nonresonant d-wave interaction in the T = 2 meson(π)-meson(π) system is reported, and it is shown its presence may affect published values of the meson(f) spin. (R.E.U.)

34631 REFINED CLUSTER WAVE FUNCTIONS FOR ^{6}Li TESTED ON COULOMB DISINTEGRATION. J. M. Hansteen and H. Wittern (Florida State Univ., Tallahassee). 9p. (CONF-452-28)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

Wave functions, obtained previously from a variational calculation with application of a central two-body interaction with hard core, are applied to observations of Coulomb disintegration of ^{6}Li ions into alpha particles and deuterons upon impact on gold at 25 to 60 Mev. (R.E.U.)

34632 SOME PROPERTIES OF VERY HIGH-ENERGY INELASTIC PROCESSES DEDUCED FROM MEASUREMENTS ON THE RECOIL BARYON. R. W. Huggett (Louisiana State Univ., Baton Rouge), K. Mori, C. O. Kim, and R. Levi Setti. 12p. (CONF-452-35; EFINS-64-13)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

The analysis of high-energy nucleon-nucleon interactions from recoil baryons emitted from cosmic jets is discussed. (R.E.U.)

34633 PROTON-PROTON INELASTIC SCATTERING AT 2 Bev. Mujaddid A. Ijaz. 12p. (CONF-452-18)

From American Physical Society, Washington, D. C., Apr. 1964.

Single pion production events of the type $p + p \rightarrow p + n + \pi^+$ and $p + p + \pi^0$, detected in exposure of a hydrogen bubble chamber to a 2-Bev proton beam, were analyzed on the basis of the isobar and one-pion-exchange models. A test of one-pion exchange suggested by Yang and Treiman was also applied. Possible evidence for a $p + \pi^+$ resonant state with $T = \frac{1}{2}$ was noted. (D.C.W.)

34634 INTERACTIONS OF STOPPING NEGATIVE PIONS WITH DEUTERIUM. Peter K. Kloeppel (Univ. of Chicago). 32p. (CONF-452-34)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

The reaction $\pi^- + d \rightarrow 2n + \gamma$ for zero-energy π-mesons was studied in a deuterium bubble chamber by observing the electron pairs produced by the internal conversion of the photons. The energy partition and mass distribution of the pairs are in agreement with the theory of Kroll and Wada. The energy spectrum was compared with the calculations of Joseph to find the effect of the neutron-neutron interaction. Satisfactory agreement is obtained if the singlet scattering length a_s is less than $-10f$. The branching ratio $\sigma(\pi^- + d \rightarrow 2n)/\sigma(\pi^- + d \rightarrow 2n + \gamma)$ was found to be 2.89 ± 0.09. The π-meson photoproduction cross section was calculated from this to be $(0.110 \pm 0.022)\eta$ mb, in contrast to the directly measured value of $(0.197 \pm 0.014)\eta$ mb. The reaction $\pi^- + d \rightarrow 2n + \pi^0$ was not seen; the fraction of captures that go through this channel is less than 0.07%. (auth)

34635 DEDUCTION OF POTENTIALS FROM SCATTERING PHASE-SHIFT DATA. P. Swan. 4p. (CONF-452-7)

From American Physical Society, Washington, D. C., Apr. 1964.

Relations are derived from which the potential can be determined, and the procedure is outlined. A case of n-p scattering is treated as an example. (D.C.W.)

34636 NON-STRANGE RESONANCES. A. Berthelot (CEN, Saclay, France). 59p. (CONF-216-7)

From International Conference on Elementary Particles, Sienna, Italy, Sept.-Oct. 1963.

Some recent findings on the decay modes, branching rations, quantum numbers, mass, and width of the mesons (ω), (ρ), and (η) are summarized, together with the knowledge of the mesons (f), (φ), and (B); the K-$\overline{K}$ enhancement; and an enhancement observed in the $K^\pm - \pi^\pm$ system from p-$\overline{p}$ annihilation. Some experimental observations on nucleonic resonances are also reviewed. 48 references. (D.C.W.)

Field Theory and Quantum Mechanics

34637 (NP-14076) SUR L'ANALYCITE DE LA MATRICE S PAR RAPPORT A LA VARIABLE MOMENT ANGULAIRE ET L'EXISTENCE DE LA REPRESENTATION DE MANDELSTAM POUR DES POTENTIELS SINGULIERS (these). (On the Analyticity of the S Matrix with Regard to the Variable Angular Moment and the Mandelstam Representation for Singular Potentials (thesis)). Maurice Giffon (Lyon. Université). [1964]. 64p.

The new relations that are released in the case of singular repulsive potentials at the r^{-n} origin were studied from the point of view of the analytical properties of the elements of the S matrix with respect to the variable angular moment. In introduction, the basic principles of a potential theory are sketched. The results of the analyticity study are given, and the conditions necessary to obtain a Mandelstam representation are outlined. The analytic properties of the S matrix with respect to the variable angular moment for "singular" potentials are reviewed. The works of Regge and Predazzi, who have shown that $S(\lambda,k)$ is a meromorphic function in λ, and that of Eden and Chalifour who proved that the Mandelstam representation is valid only for such potentials are followed. A generalization of the analytic properties is then made for potentials of the type $V(r) = A^2/r^n + W(r)$ with $n > 2$ and $W(r)$ of the "regular" type. It is shown how these results differ from those obtained with a regular potential. They are the natural generalization of those found in the case $n = 4$. The method consists in generalizing Wannier study for the properties of the Mathieu equation. (J.S.R.)

34638 THE HYDRODYNAMICAL MODEL OF WAVE MECHANICS. II. THE MOTION OF A SINGLE PARTICLE IN AN EXTERNAL ELECTROMAGNETIC FIELD. L. Jánossy and Maria Ziegler-Náray (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung., 16: 345-53(1964).

Investigations related to the hydrodynamical model of wave mechanics are continued and extended to the case of a single charged particle moving under the influence of an electromagnetic field. After establishing the appropriate basic equations describing the motion of a deformable medium, the effect of the external electromagnetic field upon the atom is investigated using the hydrodynamical model. (auth)

34639 CANONICAL QUANTIZATION OF THE SCHRÖDINGER EQUATION. L. J. Tassie (Australian National Univ., Canberra). Am. J. Phys., 32: 609-11(Aug. 1964).

It is shown that the Schrödinger equation can be quantized in a consistent manner using canonical commutation relations. (D.C.W.)

34640 THE "RADIAL KINETIC ENERGY" TERM IN THE SCHRÖDINGER EQUATION FOR A CENTRAL FORCE. Frank S. Crawford, Jr. (Univ. of California, Berkeley). Am. J. Phys., 32: 611-14(Aug. 1964). (UCRL-10999; UCRL-10999(Rev.))

The Hermitian operator corresponding to the radial component of linear momentum in the central force problem is derived. The Hermiticity of the radial momentum operator is established, and the eigenfunctions of the radial momentum operator are investigated. (D.C.W.)

34641 PHASE-SPACE OCCUPATION OF ELECTRON, PROTON, AND PHOTON BEAMS. Robert Katz and Basil Curnutte, Jr. (Kansas State Univ., Manhattan). Am. J. Phys., 32: 617-18(Aug. 1964).

The intensities of known electron, proton, and photon beams are compared to the intensity of a saturated beam of fermions, providing direct experimental evidence for the boson nature of photons. (auth)

34642 CONTRIBUTION TO THE STUDY OF UNIFIED FIELD THEORIES OF THE EINSTEIN-SCHROEDINGER THEORY-TYPE. Nguyen Phong-Chau. Ann. Inst. Henri Poincare, 18: 303-56(1964). (In French)

A theory of the type of the Einstein-Schrödinger unified theory is constructed in a manifold endowed with a general linear connection by the use of a Lagrangian linear in terms of the contractions of the curvature tensor. Approximate equations are analyzed. Problems of Cauchy, of everywhere regular stationary fields, and of physical interpretation of the theory are successively studied. (auth)

34643 COUPLED EQUATIONS FOR REARRANGEMENT COLLISIONS. Marvin H. Mittleman (Univ. of California, Livermore). Ann. Phys. (N. Y.), 28: 430-4(July 1964). (UCRL-7629)

An exact system of equations that describes the scattering of a system into a rearranged channel is derived. The method is based on a technique invented by Feshbach for deriving an equivalent Hamiltonian (or optical potential) for the scattering of a particle by a system of particles identical with it. (auth)

34644 GENERAL PROPERTIES OF ELECTRON GASES. W. Macke and P. Ziesche (Technische Universität, Dresden). Ann. Physik (7), 13: 25-40(Mar. 1964). (In German)

Data on the total energy, the kinetic energy, the potential energy, the momentum distribution, and the pair distribution were obtained by dimensional analysis and similarity transformations for the ground state of an electron gas in uniformly indistinct positive background. Momentum and pair distributions vary with the density N/V in a manner reminiscent of an uncertainty relation. With decreasing density the momentum distribution for small $h(V/N)^{-\frac{1}{3}}$ decreases and increases for large. The hole in the pair distribution for small particle distances (measured with $(V/N)^{\frac{1}{3}}$) increases with decreasing density and decreases for large particle distances. The total energy was determined through the kinetic or potential energy alone and through the momentum or pair distribution alone. The density dependence of the energy was limited by the minimum property and the asymptotic behavior for large and small densities. (tr-auth)

34645 SIMPLE ANALYTICAL APPROXIMATIONS FOR THE EQUATION OF STATE OF AN IDEAL NON-RELATIVISTIC FERMI-DIRAC GAS. Per Olof Froeman (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 26: 127-33(1964).

The possibility of obtaining simple approximate equations of state, which are approximately valid not only in the limits where the gas is either classical or completely degenerate, but also in the whole intermediate region, is shown. The equation of state is written in parametric form, and the resulting function, based on these equations and tables prepared by McDougall and Stoner, is graphically represented. (L.B.S.)

34646 ON THE ELECTRON PROPAGATOR IN THE TWO-COMPONENT FORMULATION OF QUANTUM ELECTRODYNAMICS. I. Bialynicki-Birula (Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys., 12: 231-2(1964).

It was found that there exists a gauge defined by a specific choice of the photon propagator in which the electron self-energy function in the lowest order reduces to a first-order polynomial in p^2. The only changes of the electron propagator in this gauge in the lowest order are the mass correction and a finite normalization. The renormalization constant contains no infrared or ultraviolet divergences. The propagator of a spinless particle also has simple structure in this gauge. (D.C.W.)

34647 THE POTENTIALS OF BARYON-CHARGE AND HYPER-CHARGE. C. Jankiewicz and J. Mozrzymas. Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys., 12: 281-6(1964).

The baryon-charge and hyper-charge potentials are discussed. These potentials are constructed from quantities characterizing the spinor analysis of the group $\hat{c} \otimes \hat{c}'$ with regard to the curved complex space C_4. The covariant derivatives of the $\hat{c} \otimes \hat{c}'$ spinors with respect to the complex coordinates of the space C_4 are used as the starting point in the derivation. (C.E.S.)

34648 GREEN'S FUNCTIONS. Jan Fischer (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Cesk. Casopis Fys., 14: 255-75(1964). (In Czech)

Green's function theory and its applications in solid-state physics are reviewed. (D.C.W.)

34649 ON THE MECHANICS OF PHOTON ROCKETS IN THE GENERAL THEORY OF RELATIVITY. P. Burcev (Purkyně Univ., Brno). Czech. J. Phys., 14: 294-301 (1964).

Generally covariant equations of motion of a photon rocket comprising all the basic dynamic and thermodynamic processes are derived and are written for the case of a weak gravitational field. The equations lead to results which agree with those obtained by other means. (auth)

34650 QUANTUM CORRECTIONS TO THE TRANSPORT CROSS SECTIONS. Herbert T. Wood and C. F. Curtiss (Univ. of Wisconsin, Madison). J. Chem. Phys., 41: 1167-73(Sept. 1, 1964).

By a method developed earlier, the second quantum correction to the phase shift in a collision between particles with spherically symmetric potentials is obtained. This

expression, along with the classical limit and the first correction developed earlier, is used to obtain the classical limit and the first and second quantum corrections to the transport cross sections $Q^{(1)}$ and $Q^{(2)}$. In these expressions the potential function is not restricted to monotonic functions; the results apply to a potential with an attractive minimum. (auth)

34651 NESTED HILBERT SPACES IN QUANTUM MECHANICS. [PART] I. Alexander Grossmann (New York Univ., New York and Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N. Y.), 5: 1025-37(Aug. 1964).

A nested Hilbert space is a pair of Hilbert spaces, each of which is, in a certain sense, identified with a dense subset of the other. These structures are used to study analytic continuation into unphysical sheets and to discuss nonnormalizable states of quantum-mechanical systems. (auth)

34652 EXISTENCE OF SCATTERING SOLUTIONS FOR THE SCHRÖDINGER EQUATION. Johan G. Belinfante (Univ. of Pennsylvania, Philadelphia). J. Math. Phys. (N. Y.), 5: 1070-4(Aug. 1964).

The Fredholm alternative for the Schrödinger (Lippmann-Schwinger) equation is established for potentials with finite first moment, using the Ascoli selection theorem and Banach space methods. (auth)

34653 THE REPRESENTATION OF CANONICAL VARIABLES AS THE LIMIT OF INFINITE SPACE VOLUME: THE CASE OF THE BCS MODEL. Hiroshi Ezawa (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 5: 1078-90(Aug. 1964).

The possibility of obtaining the representation suitable for a given Hamiltonian through a limiting procedure is examined. The model employed is that of the BCS superconductivity theory, for which the infinite-volume limit of the Wightman functions gives the right representation. This method is found to be helpful in analyzing the so-called symmetry breaking solutions. The meaning of the limit of infinite volume is studied with regard to the convergence of the Hamiltonian operator. (auth)

34654 NOTE ON THE EVALUATION OF SOME FERMI INTEGRALS. M. L. Glasser (Battelle Memorial Inst., Columbus, Ohio). J. Math. Phys. (N. Y.), 5: 1150-2(Aug. 1964).

A method is outlined for evaluating Fermi integrals by means of an integral representation for the derivative of the Fermi function. Several examples from free-electron diamagnetism are discussed. A convenient representation for the free energy of a Fermi gas is also derived. (auth)

34655 EQUATION OF STATE FOR A GAS WITH A WEAK, LONG-RANGE POSITIVE POTENTIAL. David S. Newman (Univ. of Washington, Seattle). J. Math. Phys. (N. Y.), 5: 1153-7(Aug. 1964).

A one-dimensional fluid model in which the pair interaction potential is exponential and repulsive is considered, and the equation of state in the long-range limit is determined exactly. This model is complementary to one studied by Kac, in which the pair potential consists of a hard core and an exponential, attractive tail. In that model a phase transition occurs, but in the current model there is no phase transition. This fact lends support to a conjecture of Ruelle that no phase transition occurs if the potential is bounded. The possibility of applying the method of Kac to a wider class of potentials is suggested, and some of the mathematical difficulties yet to be overcome are outlined. (auth)

34656 MICROWAVE SURFACE IMPEDANCE OF A PERIODIC MEDIUM. Gaston Fischer (Laboratories RCA Ltd., Zurich). J. Math Phys. (N. Y.), 5: 1158-67(Aug. 1964).

The surface impedance of a medium is calculated, the complex but scalar conductivity of which is a periodic function in a direction parallel to the surface. Radiation is assumed to impinge vertically onto the surface. It is shown that there are two independent field configurations according to whether the induced microwave current flows in a direction parallel to the conductivity pattern or perpendicular to it. These two configurations lead to different surface impedances, the one obtained in the perpendicular configuration being generally larger. The calculation is carried through when the conductivity is of the form $\sigma(y) = \sigma_0 + 2\sigma_1 \cos(ky)$, and a local relation between current and fields is assumed. Equations are also derived for the more general case in which the periodic conductivity is an arbitrary Fourier series and a nonlocal relation between current and fields is assumed. (auth)

34657 ON THE COMMUTATION RELATIONS OF WEAK CURRENTS. R. Oehme and G. Segre (CERN, Geneva). Phys. Letters, 11: 94-6(July 1, 1964).

Models for the weak current involving the strongly interacting particles are considered in connection with commutation relations and with the assumption that the divergence of the axial vector currents is approximately proportional to the appropriate field operators, which project single meson (π) or meson (K) states. (R.E.U.)

34658 PHOTONS AND GRAVITONS IN S-MATRIX THEORY: DERIVATION OF CHARGE CONSERVATION AND EQUALITY OF GRAVITATIONAL AND INERTIAL MASS. Steven Weinberg (Univ. of California, Berkeley). Phys. Rev., 135: B1049-56(Aug. 24, 1964).

A purely S-matrix-theoretic proof is given of the conservation of charge (defined by the strength of soft photon interactions) and the equality of gravitational and inertial mass. The Lorentz invariance and pole structure of the S matrix and the zero mass and spins 1 and 2 of the photon and graviton are assumed. It is proved that Lorentz invariance alone requires the S matrix for emission of a massless particle of arbitrary integer spin to satisfy a "mass-shell gauge invariance" condition. The existence of no macroscopic fields corresponding to particles of spin 3 or higher is explained. (auth)

34659 VELOCITY OF GAMMA RAYS FROM A MOVING SOURCE. T. A. Filippas and J. G. Fox (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 135: B1071-5(Aug. 24, 1964).

Serious difficulties from extinction are shown to exist in the interpretation of past experiments on gamma rays from moving sources. The relative speed of the two gamma rays emitted forward and backward by a meson (π^0) decaying in flight was measured. The velocity of the neutral pions, which were produced in the interaction $\pi^- - p \rightarrow \pi^0 - n$, was $v = 0.2c$. The results were compared with what would have been expected, taking account of extinction, on the assumption that the initial photon velocities were $c + v$ and $c - v$. The results were in complete disagreement with this assumption. (auth)

34660 A LOWER BOUND PROCEDURE FOR ENERGY EIGENVALUES. J. G. Gay (Univ. of Florida, Gainesville). Phys. Rev., 135: A1220-6(Aug. 31, 1964).

A lower bound procedure for energy eigenvalues based on the method of intermediate problems is given. A projection technique is used to construct a family of operators smaller than a given hamiltonian whose eigenvalues are lower bounds to those of the given hamiltonian. By a particular choice of subspaces associated with the projections

it is possible to construct the family in such a way that certain members may have an eigenvalue coinciding with one of the real eigenvalues of a nonlinear but finite matrix eigenvalue problem. Application to the helium atom ground state indicates that the procedure may be more efficient than the procedures customarily used. (auth)

34661 A NEW IDENTITY IN THE GREEN'S FUNCTION APPROACH TO THE MANY-BODY PROBLEM. E. R. Pike (Royal Radar Establishment, Great Malvern, Worcs, Eng.). Proc. Phys. Soc. (London), 84: 83-7(July 1964).

The basic equation of the coupled hierarchy for the energy-dependent thermodynamic Green's function of two operators is shown to be equivalent to an obvious identity. The connection between poles and excitation energies is discussed. It is shown that difficulties which arise from the use of the grand-canonical distribution may be avoided by using a simple ground-state average. (auth)

34662 UNIQUENESS OF THE HARMONIC OSCILLATOR COMMUTATION RELATION. B. Gruber and L. O'Raifeartaigh (Inst. for Advanced Studies, Dublin). Proc. Roy. Irish Acad., Sect. A, 63: 69-73(Mar. 1964).

The possibility that the usual commutation relations of quantum mechanics are a consequence of the compatibility of the Lagrange and the Heisenberg equations of motion is reconsidered for the case of the simple harmonic oscillator. It is shown that the compatibility requirement allows somewhat more general commutations and that the greater generality corresponds exactly to the possibility of quantizing the system according to Bose (the usual), Fermi and para-Fermi quantization. (auth)

34663 FEW PARTICLE EXPERIMENTS IN STATISTICAL MECHANICS. Berni J. Alder (Univ. of California, Livermore). Proc. Symp. Appl. Math., 15: 335-49([1963]). (UCRL-6917-T)

It is shown how computers can be used to explain the nature of the mathematical solution of the Liouville equation in statistical mechanics. Computer methods, advantages and disadvantages of numerical work, experimental and theoretical dependence on the number of particles, the H-function, and the diffusion coefficient are discussed. (L.B.S.)

34664 A NOTE ON THE CLUSTER EXPANSION FOR QUANTUM GASES. Hiroshi Ichimura (Univ. of North Carolina, Chapel Hill and Tokyo Inst. of Tech.). Progr. Theoret. Phys. (Kyoto), 31: 538-52(Apr. 1964).

A cluster expansion formula for the partition function of quantum gases is derived, which is particularly applicable in cases of high degeneracy. Application of the formula to the system of hard-sphere fermions readily reproduces the results obtained elsewhere. (D.C.W.)

34665 LOW-TEMPERATURE PROPERTIES OF THE INTERACTING BOSE SYSTEM. Naomi Shohno (Hiroshima Jogakuin Coll.). Progr. Theoret. Phys. (Kyoto), 31: 553-74(Apr. 1964).

The low-temperature properties of the interacting Bose system at high density are investigated under the random phase approximation and the self-consistent Hartree approximation, based on the normal-mode analysis. To treat rigorously the temperature-dependent "depletion" effect of the particles in the zero-momentum level, a new approach is proposed. As a result, the critical temperature T_c at which the zero-momentum particles disappear is determined. In the region below T_c, the temperature-dependent energy spectrum of the quasi-particles, which has at the zero-temperature an intimate connection with that of Bogoliubov, is obtained; and the property of superfluidity which disappears at T_c is discussed. It is shown that the quasi-particles are transformed into the normal Bose particles at T_c, and the temperature-dependent energy-spectrum of the normal particles in the region above T_c is determined. It is noteworthy that the phase transition of the second-order occurs at T_c. (auth)

34666 STABILITY OF VARIOUS PERTURBATIVE AND NONPERTURBATIVE SOLUTIONS APPEARING IN THE THEORY OF SPONTANEOUS BREAKDOWN OF SYMMETRIES. Kazumi Maki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 31: 698-704(Apr. 1964).

The stability of various solutions appearing in the theory of spontaneous breakdown of symmetries is investigated. It is shown for simple models that a unique solution can be chosen which is physically acceptable, if a usual analyticity of the two-particle scattering matrix is required. (auth)

34667 QUATERNIONS IN RELATIVITY. Peter Rastall (Univ. of British Columbia, Vancouver and Univ. of Texas, Austin). Rev. Mod. Phys., 36: 820-32(July 1964).

The suitability of the quaternion formalism for field theory is demonstrated. The necessary results of quaternion algebra are written, and quaternions in special relativity and Riemannian space-time are considered. (D.C.W.)

34668 SOME PROPERTIES OF THE LANDAU CURVES. John Cunningham (University Coll. of North Wales, Bangor, U. K.). Rev. Mod. Phys., 36: 833-43(July 1964).

Some properties of the Landau curves in dispersion theory are established. Several theorems on intersections, tangency, continuation, and unphysical sheets are proved or extended, and their implications are considered. (D.C.W.)

34669 A NOTE ON CLASSICAL FIELDS. Arthur E. Ruark (Atomic Energy Commission, Washington, D. C.). p.538-43 of "Isotopic and Cosmic Chemistry." Amsterdam, North-Holland Publishing Company, 1964.

A classical field with a four-potential V_i is considered. The intensities, given by the covariant derivative $V_{i,j}$, can be split into an alternating part $A_{i,j}$ and a symmetric part $S_{i,j}$ in an absolute fashion. The part A_i of the potential which gives rise to $A_{i,j}$ is unique except for an unessential gradient term. A_i has a curl, but no divergence. Likewise, S_i has a divergence, but no curl. It is assumed that first order linear differential equations govern each of the two parts of the intensity; linear, that is, in the $A_{i,j}$ and the $S_{i,j}$, respectively. The source terms must occur in these equations if they are to cover the gamut of physical situations. It is further assumed that the sources are given by a current four-vector which appears linearly. These two assumptions, together with known tensor theorems, yield Maxwell equations governing $A_{i,j}$, and also the continuity equation. Furthermore, S_i, the gradient of a superpotential S, must obey an equation div grad S = f, where f is a source function. Thus the classical counterparts of the Bose fields so far found in nature are accounted for (completely and without excess) by these simple considerations. (auth)

Geophysics

Refer also to abstract 34979.

34670 (AD-437330) SUB ELF GEOMAGNETIC FLUCTUATIONS. VOLUME II. STATISTICAL STUDIES OF HYDROMAGNETIC EMISSIONS. Final Report. R. C. Wentworth (Lockheed Missiles and Space Co., Palo Alto, Calif.). Dec. 26, 1963. Contract AF19(628)-462. 70p.

I. An empirical formula giving attenuation as a function of F2 peak ion density and hydromagnetic wave frequency

was applied to a nine-month data sample of hydromagnetic emissions (quasisinusoidal oscillations of the earth's magnetic field in the frequency interval around 1 cps). Under the hypothesis that these signals are attenuated as they propagate downward through the ionosphere as hydromagnetic waves, the amplitude and frequency spectrum above the ionosphere at middle latitudes was deduced. II. The results of Part I were applied to correct a number of studies of times of occurrence of hydromagnetic emissions at middle and upper latitudes. It is shown that most of these studies then roughly agree with the recent Heacock and Hessler, College, Alaska, study that implies a day-time predominance of occurrence. It is concluded that hydromagnetic emissions are preferentially present above the ionosphere at middle and upper latitudes during the afternoon with relative morning : afternoon : night occurrence rates of approximately 3 : 4 : 1. III. A three-year period from August 1, 1960, to July 16, 1963, was examined for the occurrence of hydromagnetic emissions at Palo Alto, California. It was found that hm emissions are more likely to occur in the seven days following geomagnetic storms than during days in geomagnetically quiet periods. (auth)

34671 (AFOSR-425) OBSERVATIONS ON THE RELATIONSHIP OF ENERGETIC PARTICLE PRECIPITATION TO AURORAL ZONE PHENOMENA. J. R. Barcus (California. Univ., Berkeley). June 1964. 34p. (AD-602434)

The precipitation of energetic electrons into the earth's atmosphere at high latitudes was studied, with interest toward periods of auroral activity. Scintillation detectors and wide-band photometers were flown in balloons during March 1963, and an all-sky camera and a 30-Mc riometer were in operation at Point Barrow, Alaska, during part of the flights. A three-component low-sensitivity magnetometer provided continuous magnetic records. Results are given that relate auroral activity to particle precipitation. (R.E.U.)

34672 AURORAL MEASUREMENTS AND UPPER ATMOSPHERIC PHYSICS. Roland E. Meyerott and John E. Evans (Lockheed Missiles and Space Co., Palo Alto, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 1169-74(July 1964).

Auroras were investigated by nearly simultaneous measurements of the particle flux and spectrum above the atmosphere, of the luminosity, and of the electron densities in the atmosphere using a satellite and airborne and ground-based observation stations in Alaska. The experiment is described, and the results are discussed. (D.C.W.)

34673 STUDIES IN GEOMAGNETISM. ON CALCULATION OF GEOMAGNETIC STORMINESS FOR HIGH-LATITUDE OBSERVATORIES. Guro Gjellestad and Helge Dalseide. Arbok Univ. Bergen, Mat.-Nat. Ser., No. 7, 1-18 (1963).

A method suitable for computers is described for calculating storminess mean hourly values from mean absolute hourly values for high-latitude stations. (D.C.W.)

34674 MODEL OF A PHOTOELECTRIC SCANNING SYSTEM FOR AURORAL HEIGHT MEASUREMENT IN REAL TIME. M. P. Wenkoff, G. G. Shepherd, and P. N. Nikiforuk (Univ. of Saskatchewan, Saskatoon, Can.). Can. J. Phys., 42: 1416-24(July 1964).

The photoelectric technique for parallactic height measurements was studied by measuring the heights of clouds in the daytime using a model of the system. The system is described, and its merits are assessed in terms of the cloud observations. (D.C.W.)

34675 CHARACTERISTICS OF THE REGION OF INTERACTION BETWEEN THE INTERPLANETARY PLASMA AND THE GEOMAGNETIC FIELD: PIONEER 5. Paul J. Coleman, Jr. (Univ. of California, Los Angeles). J. Geophys. Res., 69: 3051-76(Aug. 1, 1964).

The magnetic fields in the distant geomagnetic cavity and in the region of interaction between the solar wind and the magnetosphere were measured on March 11, 1960, using instruments aboard Pioneer 5 in the region between 5.2 and 15.4 R_e and between 1500 and 1700 local time. The observations obtained between 5.2 and 15.4 R_e are consistent with a geomagnetic boundary region that exhibits an enhanced field just inside the geomagnetic cavity and, beyond the cavity, exhibits a region of disordered fields in which both the mean field and the amplitude of the field variations decrease with increasing geocentric distance. Evidence for the extension of an interaction region to at least 25.6 R_e along the spacecraft trajectory on the day of the launch is presented. The observations are compared with two models for this interaction region. (auth)

34676 NEAR AND DISTANT OBSERVATIONS OF THE 1962 JOHNSTON ISLAND HIGH-ALTITUDE NUCLEAR TESTS. H. A. Bomke, I. A. Balton, H. H. Grote, and A. K. Harris (Army Electronics Research and Development Labs., Fort Monmouth, N. J.). J. Geophys. Res., 69: 3125-36(Aug. 1, 1964).

During the 1962 tests, high-sensitivity, high-time-resolution magnetometers were operated in the Pacific area and in the continental United States. Large loops of up to 100-km^2 area, spin-resonance (metastable-helium) magnetometers, and telluric probes were used. Shot Starfish (the July 9, 1962, explosion of about 1.5 megatons at 400 km altitude) produced very strong oscillatory signals of many minutes duration at all the stations. The signals consist of several physically different parts—a practically instantaneous broad-band pulse (observed clearly only in the Pacific area) containing mainly higher frequencies, a strong oscillatory signal starting 1.9 sec later simultaneously at all stations, a complex part lasting several minutes which is probably a superposition of different hydromagnetic modes, and an extremely long-period disturbance (observed only in the Pacific area) carrying considerable energy (interpreted as a hydrodynamic-gravitational mode). The maximum signal amplitude (occurring within 3 to 5 sec after the shot), when plotted versus distance from Johnston Island, results in a smoothly decreasing curve. Of the four other high-altitude nuclear tests above Johnston Island between October 20 and November 4, 1962, which were at various heights but all considerably lower than Starfish, none gave magnetic signals clearly above the noise level at the mainland stations. Three of the events produced clear effects at Hawaii and at Samoa. The signal-amplitude ratio (Samoa to Hawaii) becomes, for sufficiently low shot heights, a pronounced function of the explosion height, indicating that the magnetic-signal propagation becomes more and more confined to the north-south direction as the explosion height is lowered. (auth)

34677 CONCERNING A LUNAR MODULATION OF GEOMAGNETIC ACTIVITY. B. Bell and R. J. Defouw (Harvard Coll. Observatory, Cambridge, Mass.). J. Geophys. Res., 69: 3169-74(Aug. 1, 1964).

The behavior of the daily K_p index of magnetic activity was investigated as a function of lunar phase by the method of superposed epochs. The analysis indicates a slight but statistically significant enhancement of geomagnetic disturbance during several days following full moon and, with

marginal significance, a slight diminution of disturbance during several days preceding full moon. A small dip in K_p, found at the phase of new moon, is shown to be without statistical significance. (auth)

34678 GEOMAGNETIC CONTROL OF DIFFUSION IN THE UPPER ATMOSPHERE. S. Chandra and R. A. Goldberg (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 69: 3187-97(Aug. 1, 1964).

Agreement with measured data on the magnetic anomaly has been obtained from the equations of motion for electrons and ions when used with an empirical boundary condition, while poor agreement has resulted from attempts to numerically integrate the commonly employed form of the continuity equation. This discrepancy was explained by demonstrating that the assumptions used to derive this form of the continuity equations do not agree with observation. Since the equations of motion do provide a favorable description for the geomagnetic anomaly, the possible physical models leading to the form of the equations used were studied, and it was found that although field-aligned diffusive equilibrium provides the correct form, a more reasonable assumption about electron and ion collisions with neutral particles also leads to the same result. A more realistic theoretical description of the geomagnetic anomaly was obtained by using an analytic form for the boundary condition which is in better agreement with measurement than those previously used. By combining the equations of motion for neutral particles, electrons, and ions, geomagnetic control was indicated for the neutral atmosphere in the lower F region of the ionosphere, although the exact shape of this distribution is unknown. (auth)

34679 IONOSPHERIC TRANSMISSION OF TRANSVERSELY PROPAGATED PLANE WAVES AT MICROPULSATION FREQUENCIES AND THEORETICAL POWER SPECTRUMS. C. E. Prince, Jr. and F. X. Bostick, Jr. (Univ. of Texas, Austin). J. Geophys. Res., 69: 3213-34 (Aug. 1, 1964).

From attenuation and phase constants for plane waves in a partly ionized magnetoionic medium, the resultant surface magnetic field for discrete, constant-amplitude input signals at an outer boundary is calculated and presented as power spectrums. The ionosphere is assumed to be stratified, and the only mode considered is the extraordinary mode, propagating at 90° with respect to the earth's magnetic field. The results are discussed with reference to experimental power spectrums. (auth)

34680 EVIDENCE FOR >30-kev ELECTRONS ACCELERATED IN THE SHOCK TRANSITION REGION BEYOND THE EARTH'S MAGNETOSPHERIC BOUNDARY. C. Y. Fan, G. Gloeckler, and J. A. Simpson (Univ. of Chicago). Phys. Rev. Letters, 13: 149-53(Aug. 3, 1964).

The intensities of electrons and protons with energies >30 and 800 kev, respectively, were measured in several crossings of the shock transition region by Explorer 18. The electrons are confined to peaks <5000 km wide and delineate a region in space that is compatible with the expected location of the shock front at a distance of about 15 to 20×10^3 km beyond the magnetospheric boundary. The data also indicate that the electrons are accelerated beyond 30 kev at the shock transition. (D.C.W.)

Low Temperature Physics

34681 (BSD-TDR-64-87) AN EXPERIMENTAL MEASUREMENT OF THE DEPENDENCE OF THE H-I CURVE OF Nb–Zr WIRE ON TEMPERATURE. R. D. Cummings and W. N. Latham (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). July 1964. Contract AF04(694)-414. 10p. (AD-602424; AMP-141)

An apparatus used to measure the variation with temperature of the current carrying capacity of short samples of superconducting material as a function of externally applied magnetic field is described. Data are given for the following samples: (1) Westinghouse (Nb–25% Zr–0.010-in. dia. wire); (2) Westinghouse (Nb–25% Zr–0.010-in. dia. wire, heat treated); and (3) Supercon (Nb–33% Zr–0.010-in. dia. wire). (auth)

34682 (NBS-8407) ON THE CRYOGENIC ASPECTS OF PROJECT SHERWOOD. Progress Report No. 18, March 31–June 30, 1964. (National Bureau of Standards. Boulder Labs., Boulder, Colo.). 8p.

The testing of a cryogenic Al magnet to fields up to 95 kOe is described. The effects of magnetic fields on the superconductivity of thin films are investigated theoretically. Refrigeration cycles for cooling cryogenic magnets are studied, and the characteristics of one type of cycle that uses He as the working fluid are presented graphically. (T.F.H.)

34683 (NP-14136) A RESEARCH INVESTIGATION OF THE FACTORS THAT AFFECT THE SUPERCONDUCTING PROPERTIES OF MATERIALS. Progress Report No. 2, December 15, 1963–June 15, 1964. R. W. Schmitt, P. S. Swartz, H. R. Hart, Jr., R. L. Fleischer, C. P. Bean, T. A. Buchhold, and R. L. Rhodenizer (General Electric Co. Research Lab., Schenectady, N. Y.). Contract AF33(657)-11722. 51p.

This report deals with topics important for understanding and controlling a-c losses in both ordinary and hard superconductors. Losses at modest and high fields in high-field materials are governed by the critical current density, which is itself determined by the defect structure. Radiation-produced defects prove to be useful both for improving the properties of some high-field superconductors and for studying the influence of defects on critical current density. The influence of surface phenomena on the properties of high-field materials is explored; work is reported that helps delineate the conditions under which surface superconductivity is exhibited. The irreversible phenomena responsible for a-c losses can also cause heating in wires and solenoids under noncyclic conditions, a circumstance that has been examined. Finally, work on a-c losses in low applied fields, including a possible phenomenology of these losses, is presented. (auth)

34684 (UCRL-11368) SUPERCONDUCTIVITY IN SOLID SOLUTIONS OF TRANSITION METAL CARBIDES (thesis). Molly Wells (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). June 10. 1964. Contract W-7405-eng-48. 29p.

In crystal structures favorable to superconductivity in intermetallic compounds, successful empirical studies were made relating lattice parameter, electrons per atom, and electrons per unit volume to the superconducting transition temperature. The system of solid solutions of TaC and NbC was studied to ascertain whether similar empirical correlations existed for the cubic NaCl structure. Critical temperature showed a maximum higher than the critical temperature of either pure carbide. In this system, electrons per atom remained constant, while lattice parameters varied linearly. The results of this study show that the parameters successfully applied to intermetallic compounds are insufficient to describe superconductivity in the cubic NaCl system. (auth)

34685 LOW-TEMPERATURE SEALS FOR PLASTIC WINDOWS. K. B. Martin, T. H. Fields, E. G. Pewitt, and J. G. Fetkovich (Argonne National Lab., Ill.). Advan. Cryog. Eng., 9: 146-52(1964).

A double aluminum seal developed to seal the Plexiglas lens window to the stainless steel body of a 10-in. superconducting magnet bubble chamber is described. The design criteria and component assembly are discussed. Test results of a number of seal materials and configurations are tabulated, and the test apparatus is shown. Applications in other types of cryogenic apparatus are noted. (L,B,S.)

34686 STRUCTURE OF THE PERTURBATION EXPANSION FOR THE BOSE LIQUID AT ZERO TEMPERATURE. J. Gavoret (Laboratoire de Physique Théoreque et Hautes Energies, Orsay, France) and P. Nozières. Ann. Phys. (N. Y.), 28: 349-99(July 1964).

Quantum field theory techniques are used to analyze the structure of the perturbation expansion for an interacting Bose system at absolute zero. The excitation spectra associated with the one-particle and two-particle Green's functions are determined exactly in the long wavelength limit. This result is obtained by finding general relations between the diagrams contributing to the various operators involved in the problem. Particular attention is given to the study of the kernels which appear in the diagrammatic expansion of the Green's functions. An explanation of the absence of collective modes at T = 0 is obtained by a careful comparison with the corresponding Bethe-Salpeter equations in the case of a superconductor. The spectra of the quasi-particles and of the density-fluctuation excitations are shown to be identical in the long wavelength limit. Both correspond to phonons with the usual macroscopic sound velocity. The exact form of the density-fluctuation correlation function satisfies the well-known sum rules, verifying that there is no back-flow associated with the long wavelength phonons. (auth)

34687 SELF-ENERGY OF THE BOGOLIUBOV QUASI PARTICLE. Donald H. Kobe (Ohio State Univ., Columbus). Ann. Phys. (N. Y.), 28: 400-29(July 1964).

The self-energy of the Bogoliubov quasi particle, a linear combination of a particle and a hole which is used in superconductivity and nuclear superfluidity, is obtained by using the Green's functions or propagators of field theory. The exact equation for the single quasi-particle propagator is an integral equation involving multiquasi-particle propagators. The equations for the multiquasi-particle propagators are approximated by assuming that one of the quasi particles entering the higher order propagators is uncorrelated with the others. These approximate propagators are then substituted into the equation for the single quasi-particle propagator. The single quasi-particle propagator is then composed of a Hartree-Fock type term, and terms representing exciton virtual emission and absorption processes. An exciton is a collective excitation composed of a bound pair of quasi particles. The Dyson equation is used to obtain the self-energy. A simplified expression is obtained if the pairing interaction approximation is made. The exciton propagators are obtained by solving a pair of coupled integral equations. (auth)

34688 CURRENT DISTRIBUTION IN SUPERCONDUCTING FILMS CARRYING QUANTIZED FLUXOIDS. J. Pearl (RCA Labs., Princeton, N. J.). Appl. Phys. Letters, 5: 65-6(Aug. 15, 1964).

The current distribution in superconducting films supporting vortex-type fluxoids having a pin-shaped core surrounded by circulating currents is investigated. (D.C.W.)

34689 THE NEW HYDROGEN LIQUEFIER AT THE CLARENDON LABORATORY. A. J. Croft (Oxford Univ.). Cryogenics, 4: 143-52(June 1964).

A liquefier is described in which pre-cooling is by two liquid nitrogen baths (77 and 64°K). The liquefaction rate (internal) is 31 l/hr with a pressure before expansion of 52 atm. The liquefaction rate can be increased to 40 l/hr by use of an additional compressor. Operation and performance of the device are outlined. (D.C.W.)

34690 FIELD ENERGY REMOVAL FROM A SUPERCONDUCTING SOLENOID. M. W. Dowley (International Business Machines Corp., San Jose, Calif.). Cryogenics, 4: 153-65(June 1964).

The principles of three basic methods of extracting the field energy from a superconducting solenoid are presented. The requirements for their efficient performance are stated, and their merits are discussed in terms of experimental results. (D.C.W.)

34691 ONSET AND GROWTH OF VORTICITY IN LIQUID HELIUM-II. S. M. Bhagat, P. R. Critchlow, and K. Mendelssohn (Oxford Univ.). Cryogenics, 4: 166-73 (June 1964).

The development of vorticity in coiled silver capillaries was followed by heat conductivity measurements. The progress of turbulent fronts at steady rates along the tubes was verified. A basic pattern of turbulence spreading from both ends was observed and was studied as a function of heat current and temperature. More complex spread patterns were analyzed under the assumption of multiple sources. Phenomena occurring at the junction of two flow tubes were also recorded. (D.C.W.)

34692 ON THE INTEGRODIFFERENTIAL EQUATIONS OF THE NONLOCAL THEORY OF SUPERCONDUCTIVITY. Farouk M. Odeh (International Business Machines Corp., Yorktown Heights, N. Y.). J. Math. Phys. (N. Y.), 5: 1168-82(Aug. 1964).

Existence and uniqueness theorems are given for the solutions of the integrodifferential equations governing the vector potential, under suitable restrictions on the kernels involved. Both diffuse and specular reflection types of boundary conditions are considered in both scalar (one-dimensional) and vector (three-dimensional) problems. An existence theorem is also given for the time-dependent equations. Approximate solutions for the problem of a film in a parallel magnetic field are given in two limiting cases. In one the small-coherence-length limit in the Pippard model under diffuse scattering boundary conditions is considered, and a boundary-layer-type solution is given. In the other a thin-film approximation to the diffuse problem is found. An exact series representation is also given for the solution of the problem of a circular cylinder in a parallel magnetic field with specular reflection boundary conditions. (auth)

34693 SUPERCONDUCTING BEHAVIOR OF BINARY AND ISOELECTRONIC ALLOYS OF LEAD AND TIN. Gérard Chol (École Supérieure de Physique et Chimie, Paris). J. Phys. (Paris), 25: 374-80(Apr. 1964). (In French)

The effect of impurities (Z ± 1) on the superconducting behavior of a metal (lead or tin), where Z is the atomic number of the metal, was investigated. The Sommerfeld coefficient γ was obtained from the critical field-temperature; and the density of states curves near the Fermi level were obtained from the relation of γ and the density of states, using the rigid band model. The isoelectronic alloys constituted an equiatomic mixture of Z − 1 and Z + 1 impurities in the metal. For very dilute alloys, it was proved

that the electronic specific heats of the pure metal and the isoelectronic alloy are equal and lie between those of the corresponding binary alloys at equal concentration. For higher concentrations, however, the electronic specific heat of the pure metal is slightly less than that of the isoelectronic alloy. The rigid band model was verified, and the shape of the lead and tin bands near the Fermi level was determined. (D.C.W.)

34694 WAVE PROPAGATION AT VERY LOW TEMPERATURE. SUPERCONDUCTIVITY AND SUPERTRANSPARENCY. G. Pocholle. Onde Elec., 43: 1235-47(Dec. 1963). (In French)

It is shown that the thermodynamic superconductivity of metals can be explained on the basis of Planck's law. The Joule effect results from interaction between the electrical or electromagnetic energy of propagation and the internal thermal energy of the material. The second part of Joule's law is stated and shown to hold for conducting metals and dielectrics. Specifically, the resistivity and conductivity of conductors and dielectrics, respectively, vary with the temperature as the integral of the specific heat at constant volume. The quantization of the thermodynamic entropy is briefly considered, together with the hypothesis of supertransparency at very low temperatures. (D.C.W.)

34695 LOW-TEMPERATURE SPECIFIC HEAT MEASUREMENTS OF EuSe AND EuTe. G. Busch, P. Junod, R. G. Morris, J. Muheim, and W. Stutius (Eidgenossische Technische Hochschule, Zurich). Phys. Letters, 11: 9-10 (July 1, 1964).

Sample preparation and procedures for measuring the specific heats of EuSe and EuTe at 1.3 to 20°K are discussed. Transition temperatures and Debye temperatures are given. (R.E.U.)

34696 MICROWAVE OBSERVATION OF QUANTUM INTERFERENCE EFFECTS IN SUPERCONDUCTORS. J. Lambe, A. H. Silver, J. E. Mercereau, and R. C. Jaklevic (Ford Motor Co., Dearborn, Mich.). Phys. Letters, 11: 16-17(July 1, 1964).

The observation of quantum interference effects in Josephson tunneling is reported. Samples of tin and lead were placed in a microwave cavity with the electric field in the plane of the sample. The impedance was studied with a superheterodyne bridge spectrometer at 9400 Mc. An external magnetic field was used to scan through the interference pattern. (R.E.U.)

34697 THERMAL BOUNDARY RESISTANCE BETWEEN SOLIDS AND HELIUM BELOW 1°K. A. C. Anderson, J. I. Connolly, and J. C. Wheatley (Univ. of Illinois, Urbana). Phys. Rev., 135: A910-21(Aug. 17, 1964). (TID-20473)

Results are reported from measurements of the thermal boundary resistance between liquid ^{3}He and copper or epoxy resin, and between solid ^{3}He or liquid ^{4}He and copper. Measurements were made in the range 0.05 to 0.9°K and at pressures up to 395 psi. No quantitative agreement has been found with theory. Above 0.11°K, the thermal boundary resistance of liquid ^{3}He and liquid ^{4}He both have a temperature dependence stronger than T^{-3}. Below 0.11°K the thermal boundary resistance of ^{3}He varies as T^{-3} over the full pressure range in the liquid. In the case of ^{4}He at low pressure, however, the stronger temperature dependence continues to the lowest temperature measured (0.075°K). It is not clear whether the qualitative difference in the behavior of liquid ^{3}He and liquid ^{4}He is associated with zero sound in liquid ^{3}He. (auth)

34698 FLUXOID CONSERVATION BY SUPERCONDUCTING THIN FILM RINGS. T. K. Hunt and J. E. Mercereau (California Inst. of Tech., Pasadena). Phys. Rev., 135: A944-50(Aug. 17, 1964).

A torque method for measuring the persistent current in superconducting rings was used to investigate the conservation of the fluxoid originally predicted by London. The fluxoid through a superconducting ring is composed of two parts, one describing the mechanical angular momentum of the electrons and the other the magnetic flux trapped by the ring. The mechanical angular momentum depends on the penetration depth λ and therefore on the temperature. If the fluxoid is conserved, temperature variations should alter the balance between the mechanical and electromagnetic angular momenta. As a consequence, the amount of trapped flux, and hence the persistent current, should vary with temperature even though the ring remains at all times entirely within the pure superconducting state with zero resistance. Very thin films of tin have shown experimentally a decrease in persistent current with increasing temperature and an increase with decreasing temperature which agree with that to be expected on the basis of the fluxoid conservation predicted by London. (auth)

34699 THERMAL RESISTANCE AT INDIUM-SAPPHIRE BOUNDARIES BETWEEN 1.1 AND 2.1°K. D. A. Neeper and J. R. Dillinger (Univ. of Wisconsin, Madison). Phys. Rev., 135: A1028-33(Aug. 17, 1964).

The thermal resistance at boundaries between indium and single crystal sapphire was measured with the indium superconducting and normal. The effective temperature at the sapphire side of a boundary was determined from the condition of radiative equilibrium at the surfaces of the crystal. It was found that the thermal conductance of indium-sapphire boundaries can be represented by the sum of a T^2 term and a T^3 term. For two samples, the T^3 terms are, respectively, $0.0295T^3$ and $0.0281T^3 \pm 0.0016T^3$ w/(cm^2–deg). These numbers are within the range of possible values expected on the basis of the acoustic mismatch theory of Little. For the two samples the T^2 terms are $0.0059T^2$ and $0.0098T^2 \pm 0.001T^2$ w(cm^2–deg) with the indium superconducting, and are increased by $(1 \pm 0.4) \times 10^{-3}T^2$ when the indium is normal. The values obtained as a matter of course for the thermal conductivity of sapphire are in agreement with the Casimir theory as modified to include the effects of finite crystal length and specular reflection of phonons at the crystal surfaces. (auth)

34700 CALORIMETRIC INVESTIGATION OF LOCALIZED MAGNETIC MOMENTS AND SUPERCONDUCTIVITY IN SOME ALLOYS OF TITANIUM WITH MANGANESE AND COBALT. R. R. Hake and J. A. Cape (Atomics International, Canoga Park, Calif.). Phys. Rev., 135: A1151-60 (Aug. 31, 1964).

The specific heats C of arc-cast specimens of Ti and alloys of Ti with Mn and Co were measured between 1.2 and 4.5°K. For ≈99.92 wt % pure h-c-p Ti, the standard $C = \gamma T + \beta T^3$ relation is closely obeyed, with $\gamma = 3.30 \pm 0.03$ mJ/mole (°K)^2 and $\beta^{-1/3} \propto \theta_D = 429 \pm 7$°K. For h-c-p Ti alloys containing 0.17–1.7 at. % (nominal atomic percent) Mn observations show a large excess specific-heat contribution which increases with decrease of temperature, evidently associated with ordering of magnetic moments localized at the Mn ions, and no calorimetric evidence of a standard bulk superconducting transition. Neither a large localized-moment-type specific-heat contribution nor a standard bulk superconducting transition is calorimetrically observed in h-c-p Ti-1 at. % Co. The absence of standard bulk superconducting transitions in dilute h-c-p Ti–Mn and Ti–Co is in apparent conflict with earlier magnetic evidence for elevation of the superconducting transition temperature T_c above 1.2°K in such alloys. That

dilute Mn addition to the h-c-p Group-IV transition elements Ti or Zr actually lowers T_c is suggested by the observation that 0.2 at. % Mn added to the superconducting alloy h-c-p Ti-50 at. % Zr [$T_c = 1.60°K$, $\gamma = 4.2$ mJ/mole $(°K)^2$, $\theta_D = 304°K$] induces localized-moment behavior in the magnetic susceptibility and specific heat, eliminates the standard bulk calorimetric superconducting transition, and results in a broad and incomplete resistance-versus-temperature superconducting transition. In contrast to the behavior of h-c-p Ti-Mn and Ti-Zr-Mn alloys, a predominantly b-c-c Ti-14 at. % Mn alloy displays standard normal-state specific heat behavior with no evidence of localized moments, and a standard calorimetric superconducting transition at $T_c = 2.55°K$. The formation and interaction of dilute localized moments in Ti and Ti-Zr, and the effect of the localized moments on superconductivity, are qualitatively discussed. (auth)

34701 ULTRASONIC DETERMINATION OF THE SUPERCONDUCTING ENERGY GAP IN THALLIUM. G. A. Saunders and A. W. Lawson (Univ. of California, Riverside). Phys. Rev., 135: A1161-5(Aug. 31, 1964).

The temperature-dependent energy gap $2\Delta(T)$ in single crystals of high-purity thallium was determined by measurements of the attenuation in the normal and superconducting states of longitudinal acoustic waves. Determinations were made for sound-wave propagation along the [0002], [10$\bar{1}$0], and [1$\bar{2}$10] crystallographic axes. The energy gap $2\Delta(0)$ at 0°K for propagation along these axes, respectively, was found to be $3.76\ kT_c \pm 0.03\ kT_c$, $4.10\ kT_c \pm 0.03\ kT_c$, and $4.00\ kT_c \pm 0.10\ kT_c$. Ultrasonic attenuation gives a larger value for this limiting energy gap than that observed by other methods. The decrease in attenuation below T_c was found to be more abrupt than predicted by the Bardeen-Cooper-Schrieffer (BCS) theory. It is suggested that the simple BCS model does not give a complete picture of the ultrasonic attenuation in very pure superconductors. (auth)

34702 HARD-SPHERE APPROACH TO THE EXCITATION SPECTRUM IN LIQUID HELIUM II. L. Liu (Northwestern Univ., Evanston, Ill.), Lu Sun Liu, and K. W. Wong. Phys. Rev., 135: A1166-72(Aug. 31, 1964).

The excitation spectrum of a Bose system of hard spheres is obtained in a high-density calculation including multiple scattering processes. The hard-sphere interaction is represented by a non-Hermitian pseudo-potential constructed in a previous work, and the T-matrix method of Brueckner and Sawada is adopted with modifications to take into account the non-Hermitian property of the hamiltonian. The inclusion of multiple scattering is found essentially to give a screening effect to the two-body interaction in a many-body medium. The screening factor is studied within certain approximations and is shown to play a very important role in determining the shape of the excitation spectrum. The effect of depletion of particles from the zero-momentum state due to particle interaction is also included in a self-consistent way and is found to be very small. The calculated spectrum is then applied to liquid helium and there is a good qualitative agreement with experiments. Especially, a roton-type dip exists in the spectrum. (auth)

34703 FINITE SUPERCONDUCTORS AND THEIR INFINITE VOLUME LIMIT. E. M. Henley, R. C. Kennedy, and L. Wilets (Univ. of Washington, Seattle). Phys. Rev., 135: A1172-4(Aug. 31, 1964). (TID-20555)

It is demonstrated that the standard applications of the BCS theory to finite systems does not possess the proper asymptotic behavior as the size of the system becomes infinite. In particular, no coupling exists from discrete states to those of positive energy unless the two-body potential is very strong (i.e., stronger than nuclear potentials). Two methods of correcting this deficiency are suggested: a generalization of the BCS variational wave function, and an extension of the Bogoliubov principle of compensating dangerous diagrams. (auth)

34704 CONCERNING THE RATIO H_{c3}/H_{c2} IN SUPERCONDUCTING Nb AND Nb-O SOLUTIONS. Warren DeSorbo (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 135: A1190-3(Aug. 31, 1964).

The Saint-James-de Gennes relation between H_{c2} and H_{c3} in type II superconductors was verified in Nb and Nb-O interstitial solid solutions. The observed ratio $H_{c3}/H_{c2} = 1.7_0$ is found to be independent of κ, the Ginsburg-Landau parameter, for niobium-containing oxygen in concentrations below the solubility limit at the temperature of introduction. Critical-current data I_c versus H above H_{c2}, analyzed in terms of a dimension of the superconducting sheath, (e.g., $J_s = I_c$ per cm width), reveal sharp breaks at H_{c3} when the material becomes normal. For a cold-worked specimen, two portions of the $J_s(H)$ curve may be identified, meeting at a definite field corresponding to H_{c3} calculated from theory. The upper portion of the curve first meets the normal state curve at a field H_n. The ratio H_n/H_{c2} is larger for cold-worked niobium than for cold-worked niobium-oxygen alloys. (auth)

34705 MICROWAVE SURFACE IMPEDANCE OF SUPERCONDUCTORS OF THE SECOND KIND. Gaston Fischer (RCA Labs., Ltd., Zurich). Phys. Rev., 135: A1202-9(Aug. 31, 1964).

A simplified model of the mixed state of a superconductor of the second kind is proposed. The generation and parallel alignment of fluxoids under the influence of an externally applied magnetic field results in a medium whose conductivity is position-dependent in all directions perpendicular to the applied field. The proposed model is that of a two-fluid superconductor with carrier concentrations sinusoidally space-modulated in only one direction. This model is found to account extremely well for the experimentally observed behavior. In particular, the large dependence of the absorption of energy on the relative angle between applied d-c field and induced microwave current is satisfactorily explained. The ratio of absorbed energies in the perpendicular and parallel configurations is predicted to lie between 1 and 7, whereas recent experiments with various materials yielded ratios between 1 and 15. The model also predicts that this anisotropy is not very dependent on temperature and applied magnetic field, also in agreement with experimental findings. (auth)

34706 STABILITY OF CRYSTALS OF RARE-GAS ATOMS AND ALKALI HALIDES IN TERMS OF THREE-BODY INTERACTIONS. I. RARE-GAS CRYSTALS. Laurens Jansen (Battelle Memorial Inst., Geneva). Phys. Rev., 135: A1292-1306(Aug. 31, 1964).

Several attempts were undertaken in the literature to explain the observed stability of the face-centered-cubic configuration for rare-gas crystals (except helium), which structure, according to calculations based on pair potentials, should be somewhat less stable than that of hexagonal closest packing. These attempts failed or the results were found to be inconclusive. It is shown how the f-c-c stability can be explained in terms of three-body exchange interactions between nearest neighbors in the crystals. On the basis of detailed results for neon atoms, the stability analysis may be based on an effective-electron model with Gaussian distribution of charge. No multipole expansions are invoked. The three-body interactions in first and sec-

ond orders of perturbation theory follow simple symmetry principles, and their combined effect stabilizes the f-c-c over the h-c-p structure by a difference of up to four percent of the cohesive energy for the heavier atoms. Finally crystal stability is considered in its relation to total cohesive energy, and energy of vacancy formation, for the close-packed structures. (auth)

34707 SUPERCONDUCTIVITY IN THE ARTIFICIAL METALS: METALLIC INDIUM ANTIMONIDE, THE INDIUM–ANTIMONIDE–TIN ALLOYS, AND METALLIC INDIUM TELLURIDE. B. R. Tittmann, A. J. Darnell, H. E. Boemmel, and W. F. Libby (Univ. of California, Los Angeles). Phys. Rev., 135: A1460-2(Aug. 31, 1964).

Superconductivity was observed in metallic indium antimonide, in the alloys of indium antimonide with tin, and in indium telluride. The compounds and alloys were prepared and stabilized at atmospheric pressure in the way described by Darnell and Libby. Superconducting transition temperatures and critical magnetic fields were obtained by the eddy-current decay method used in measuring resistivities. (auth)

34708 INFLUENCE OF THE PHONON SPECTRUM ON THE DENSITY OF ELECTRON STATES IN SUPERCONDUCTING TANTALUM. A. F. G. Wyatt (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 13: 160-2 (Aug. 3, 1964).

The effect of the phonon spectrum on the density of states was investigated by measuring the first and second derivatives of the current-voltage characteristic of a Ta-insulator-Ag junction at 0.9°K. The data indicate that electron-phonon interactions are responsible for superconductivity in Ta. (D.C.W.)

34709 OBSERVATIONS OF THE ESTABLISHMENT OF THE QUANTIZED FLUX STATE IN TIMES AS SHORT AS 10^{-5} SEC. Alvin L. Kwiram and Bascom S. Deaver, Jr. (Stanford Univ., Calif.). Phys. Rev. Letters, 13: 189-90 (Aug. 10, 1964).

The flux change occurring in hollow tin cylinders cyclically cooled through the transition temperature in an applied axial magnetic field was observed at frequencies to 55 kc. A periodic variation as a function of applied field was found at all frequencies, indicating that quantized flux was established at least as rapidly as 10^{-5} sec. The period was measured to be hc/2e within the experimental error of 3%. (D.C.W.)

34710 RADIO-FREQUENCY EFFECTS IN SUPERCONDUCTING THIN FILM BRIDGES. P. W. Anderson and A. H. Dayem (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 13: 195-7(Aug. 10, 1964).

Radiofrequency power in the frequency range from 200 to 10^4 Mc was applied to a number of thin tin film bridges by a loop terminating in a coaxial loop, and the modifications in the d-c current-voltage characteristics of the bridges were observed. The data were interpreted in terms of quantized vortices as a resistive effect in a fully superconducting sample. (D.C.W.)

34711 GERMANIUM TELLURIDE: SPECIFIC HEAT AND SUPERCONDUCTIVITY. Leonard Finegold (Univ. of California, Berkeley). Phys. Rev. Letters, 13: 233-4 (Aug. 17, 1964).

The heat capacity of a large germanium telluride sample was measured at low temperatures with no magnetic field and with a 500-gauss magnetic field. With no magnetic field, a maximum in the specific heat was observed below 0.3°K; the maximum disappeared in the 500-gauss field. The existence of bulk superconductivity in germanium telluride was established. (D.C.W.)

34712 MAGNETIC AND CALORIC EFFECTS IN A HARD SUPERCONDUCTOR. S. H. Goedemoed, C. van Kolmeschate, D. de Klerk, and C. J. Gorter (Kamerlingh Onnes Laboratorium, Leiden). Physica, 30: 1225-8 (June 1964).

Magnetization curves and hysteresis loops for a sample of impure niobium were obtained at several low temperatures. The sample consisted of 100 parallel wires glued together around a Constantan wire. The temperature of the sample was also observed during the variation of the magnetic field. (D.C.W.)

34713 SOME REMARKS ON THE UPPER CRITICAL FIELD OF THE SUPERCONDUCTIVITY OF NIOBIUM. G. J. van den Berg and H. J. M. van Rongen (Kamerlingh Onnes Laboratorium, Leiden). Physica, 30: 1229-30(June 1964).

The slope of the curve of the critical field as a function of temperature at 0°K was investigated by experiments between 0.5 and 4.0°K, together with the effect of a different purity on the shape of the curve. The results indicate a zero slope at 0°K. The upper critical field at 0°K in one wire as determined by electric resistance measurements was twice that obtained by extrapolation of magnetization measurements. (D.C.W.)

34714 MICROWAVE AMPLIFICATION WITH SUPERCONDUCTORS. A. S. Clorfeine (Radio Corp. of America, Princeton, N. J.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 52: 844-5(July 1964).

Experiments which demonstrated a nonlinear inductance and frequency conversion in superconducting films at 54 kMc were repeated at lower frequencies on films about 250 Å in thickness. Parametric amplification and oscillation were observed. At 2°K, the modified dielectric resonator yielded 11 db of net gain at 6.06 kMc. The pump power required for amplification was only 0.2 μw. (D.C.W.)

34715 DISCUSSION ON APPLICATIONS OF SUPERCONDUCTING MATERIALS. Proc. Inst. Elec. Engrs. (London), 111: 407-13(Feb. 1964).

The status of Nb–Zr and Nb_3Sn superconducting magnets is summarized, and experimental and theoretical aspects of high-field superconductors in alternating fields and of applications, particularly in a-c equipment, of superconductivity are discussed. (D.C.W.)

34716 THE THICKNESS OF THE MOVING HELIUM II FILM. J. Tilley (Univ. of St. Andrews, Scotland). Proc. Phys. Soc. (London), 84: 77-82(July 1964).

The conflicting theories of the thickness of the moving helium II film given by Kontorovich and Franchetti are examined. The former is found to be consistent with the basic postulates of the two-fluid model, while Franchetti's derivation is shown to require correction. By arguments based on the thermodynamics of a system in which relative motion occurs, the two approaches are reconciled, confirming Kontorovich's result that the moving film is thinner than the static film. (auth)

34717 LOW-TEMPERATURE DYNAMIC NUCLEAR POLARIZATION. W. A. Barker (St. Louis Univ. and Argonne National Lab., Ill.), Mohan Lal Narchal, Sushil Misra, Albert J. Bevolo, Francis X. Haas, Claire M. Birkbeck, Barbara M. Kuehne, and John C. Witte. Rev. Mod. Phys., 36: 872-9(July 1964).

The exact Boltzmann factor is used to calculate the normalized steady-state population distribution from which the nuclear polarization, enhancement of NMR, internal energy, entropy, and heat capacity for the 28 cases previously treated are calculated, plotted, and examined. The limiting values of these quantities at T = 0 are tabulated and dis-

cussed in relation to the third law of thermodynamics. (D.C.W.)

34718 THE HEAT CONDUCTIVITY OF SOLID HELIUM-4. L. P. Mezhov-Deglin (Inst. of Physical Problems, Academy of Sciences, USSR and Inst. of Solid State Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 46: 1926-7(May 1964). (In Russian)

Solid He is a suitable material for studying the heat transfer processes in dielectric crystals because it is not contaminated chemically and its high compressibility makes it possible to change the Debye temperature of the crystal by a factor of about 2 at a relatively low pressure of 250 atm., without distorting the lattice symmetry; thus, the applicability of theoretical models of transport processes may be conveniently verified. Using the method developed by A. I. Shal'nikov for the direct observation of the solidification process, He crystals were grown at practically constant temperature. They were formed in $1\frac{1}{2}$ hours at 82 atm. (θ_D = 33.7°K) and at 185 atm. (θ_D = 43.5°K). Heating the crystals to a temperature near the melting point did not affect the heat conductivity. The temperature dependence curves of the heat conductivity of the crystals grown in different experiments at the same pressure usually differ slightly; this might be due to errors in the pressure measurements or to the formation of crystals having a different orientation. The data, although somewhat lower, agreed quite well with the previously reported values in the low heat-conductivity range; the highest observed value exceeded the data reported by E. J. Walker and H. A. Fairbank by a factor of 2.5. The Kapitsa jump at the solid ^{4}He–Cu boundary was also noted; the order of magnitude of the observed temperature difference agreed well with the theoretically predicted value. (TTT)

34719 PHASE TRANSITION IN SUPERCONDUCTORS. E. G. Batyev, A. Z. Patashinskii, and V. L. Pokrovskii (Inst. of Radiophysics and Electronics, Academy of Sciences, Siberian SSR). Zh. Eksperim. i Teor. Fiz., 46: 2093-2101(June 1964). (In Russian)

It is demonstrated that phase transition in superconductors takes place in the same way as in Bose fluids. Cooper pairs play the role of bosons. The specific heat possesses a logarithmic singularity in a very narrow temperature interval. (auth)

34720 EFFECT OF COLLECTIVE EXCITATIONS ON THE ELECTRODYNAMICS OF SUPERCONDUCTORS. A. I. Larkin. Zh. Eksperim. i Teor. Fiz., 46: 2188-2201(June 1964). (In Russian)

The electromagnetic properties of superconductors are studied without assuming a weak interaction between the electrons. The surface impedance is found by taking into account collective excitations. The results obtained can be used for explaining the absorption of infrared radiation in lead and mercury. The refraction coefficient of collective excitations is found for a surface employed in investigations of superconducting films whose thickness is greater than the penetration depth. (auth)

34721 NONLINEAR EFFECTS IN THE ELECTRODYNAMICS OF SUPERCONDUCTORS. A. I. Rusinov and E. A. Shapoval (Inst. of Problems in Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 46: 2227-40 (June 1964). (In Russian)

The dependence of the energy gap of a superconductor and the depth of penetration of a stationary magnetic field on the field strength is investigated on basis of the microscopic theory. The analysis is carried out for arbitrary temperatures. Limiting cases of absolute zero and of temperatures close to T_c are considered in detail for Pippard and London superconductors. (auth)

34722 ELECTRON-PHONON INTERACTION AND SUPERCONDUCTIVITY. J. R. Schrieffer (Univ. of Pennsylvania, Philadelphia). p.343-72 of "Phonons and Phonon Interactions." New York, W. A. Benjamin, Inc., 1964.

Superconductivity theory is outlined emphasizing the role of electron-phonon interaction. (D.C.W.)

34723 SUPERCONDUCTING BEHAVIOR OF SUPERIMPOSED THIN FILMS OF Al AND Sn. D. S. Schreiber and W. D. Knight (Univ. of California, Berkeley). 7p. (CONF-452-16)

From American Physical Society, Washington, D. C., Apr. 1964.

Nuclear magnetic resonance and resistivity measurements on multiple alternating layers of Sn and Al in the temperature range between 1.5 and 4.2°K are reported. The accepted transition temperatures of Al and Sn are 1.2 and 3.75°K, respectively. (auth)

34724 OBSERVATIONS ON THE BEHAVIOR AND STRUCTURE OF FLUX JUMPS IN A HARD SUPERCONDUCTOR. M. A. R. LeBlanc and F. L. Vernon, Jr. (Aerospace Corp., Los Angeles and Univ. of Southern California, Los Angeles). 9p. (CONF-543-8)

From American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964.

The results are presented of some observations of major flux jumps in an Nb–Zr wire carrying a transport current at 1.5, 2.4, and 4.2°K in transverse magnetic fields less than 18 kG. The sample was a single layer coil with an external magnetic field parallel to its axis. (D.C.W.)

34725 FOURTH SOUND IN HELIUM II. Kenneth A. Shapiro (Univ. of California, Los Angeles). 50p. (CONF-452-29)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

Fourth Sound is a pressure and density wave in Helium II, in which only the superfluid is in motion. The existence of this wave mode was substantiated experimentally by measuring the frequency of a plane-wave resonance in a closed-closed cylindrical acoustic resonator, as a function of the absolute temperature. The resonator was filled with a porous medium that allowed only superfluid motion. The velocity values, which were derived from the frequency data, agree to 1% with the temperature dependence predicted theoretically. The absolute value of the Fourth Sound velocity is affected by the coherent multiple scattering of the wave from the superleak material. An empirically determined correction predicts the effect of multiple scattering, as a function of superleak porosity, to 3%. The theoretical multiple scattering formulas yield results that are corrected in sign, but not in magnitude. Values of the ratio of the superfluid to the Helium II density derived from the Fourth Sound data, which were corrected for multiple scattering effects, agree to 2% with those gathered by other experimental techniques, and afford greater temperature resolution than obtained previously. (auth)

Neutron Physics

Refer also to abstracts 34752 and 34753.

34726 (AWRE-O-21/64) THE CALCULATION OF NEUTRON SURFACE MULTIPLICATIONS OF TRANSPORT CONTAINERS. E. D. Pendlebury and Patricia E. Garrett (United Kingdom Atomic Energy Authority. Weapons

Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). July 1964. 27p.

It is shown that the most efficient way to calculate the neutron surface multiplication of a proposed transport container is to solve a suitable adjoint problem. By this means the maximum useful information is obtained from a given amount of computational effort. A single calculation gives the surface multiplication as a function of incident neutron energy, from which the maximum surface multiplication and the incident neutron energy that produces it are immediately obtained, and it also becomes a trivial matter to study the effect of varying the incident energy distribution. (auth)

34727 (CEA-R-2368) MÉTHODES THÉORIQUES POUR L'ÉTUDE DE LA THERMALISATION DES NEUTRONS DANS LES MILIEUX ABSORBANTS INFINIS ET HOMOGÈNES. (Theoretical Methods for Study of Neutron Thermalization in Absorbing Infinite and Homogeneous Media). Michel Cadilhac (France. Commissariat a l'Energie Atomique. Centre d'Études Nucléaires, Saclay). 1964. 62p.

Thesis submitted to Université, Paris.

After a general survey of the theory of neutron thermalization in homogeneous media, a simplified model generalizing both the Horowitz model (generalized heavy free gas approximation) and the proton gas model is introduced. When this model is used, the calculation of spectra is reduced to the solution of linear second-order differential equations. Since it depends on two arbitrary functions, the model gives a good approximation of any usual moderator for reactor physics purposes. The choice of these functions is discussed from a theoretical point of view; a method based on the consideration of the first two moments of the scattering law is investigated. The possibility of discriminating models by using experimental informations is considered. (auth)

34728 (DTMB-1814) MODIFIED P_2 APPROXIMATIONS TO THE NEUTRON TRANSPORT EQUATION. Charles Dawson (David Taylor Model Basin. Applied Mathematics Lab., Carderock, Md.). Apr. 1964. 22p.

The steady-state neutron transport equation for slab geometry is expanded in Legendre polynomials. The expansion is truncated after the third term (P_2 equations) and then is modified in an attempt to reduce the truncation error. The resulting equations are, for many problems, a better approximation to the neutron transport equation than the P_2 equations or the standard diffusion equations. The method is extended to two and three dimensions by a simplified form of the spherical expansion to the neutron transport equation. Sample results are given. (auth)

34729 (IDO-16968) TOPIC—A FORTRAN PROGRAM FOR CALCULATING TRANSPORT OF PARTICLES IN CYLINDERS. G. E. Putnam (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Apr. 1964. Contract AT(10-1)-205. 100p.

The TOPIC codes are designed to solve the one-dimensional Boltzmann equation in cylindrical geometry with up to six energy groups, two hundred and forty space points, forty regions, and anisotropic (P_1) scattering. The boundary conditions for each group can be independently specified and the flexibility of the specifications permit: (a) Perfect mirror reflection or symmetry; (b) Isotropic reflection (Lambert surface reflection); and (c) Anisotropic diffuse sources by means of either a P_1 Legendre series or a short table of point values for the angular flux. Independent specification of isotropic fixed volume sources for each group is also allowed. Both homogeneous and inhomogeneous problems are solved, and fissions can occur in either type of problem. A direct method of solution, which was shown to be effective in the MIST code, is used to solve for some of the angular flux points in each group and an inner iterative solution is used to solve for the others. The result is that most problems converge in as few outer iterations as diffuse theory solutions, and usually only one or two inner iterations need be performed. The numerical approximation to the Boltzmann equation is a linear one with respect to variation in the space variable r and one of the angular variables. Gauss quadrature is used to handle the second (polar) angular variable. TOPIC solutions require about 50% more time than would the solution of a comparable problem with MIST. An S_4 problem with four groups of neutrons, 75 mesh points, and 3 Gauss quadrature points took 5 outer iterations to converge to a pointwise variation of less than the fraction 1×10^{-3}. The running time was 2.93 minutes on the 7090. A comparable MIST problem took 2.1 minutes. Because of the automatic tape buffering available with the Fortran IV monitoring system, some of the inefficiencies of the Fortran II version of TOPIC are removed when the program is run on the 7040. Consequently, TOPIC problems require less time on the IBM 7040, even though it is a basically slower machine. (The times required are usually from 0.4 to 0.9 of the time required on the 7090.) (auth)

34730 (KR-77) BIGG-I—A MULTIGROUP NEUTRON SPECTRUM AND CRITICALITY CODE. O. P. Tverbakk and J. M. Doderlein (Norway. Institutt for Atomenergi, Kjeller). Apr. 1964. 73p. (NORA-12)

A complete description of the BIGG-I code for the Ferranti Mercury computer is given. BIGG-I is a multigroup Fourier transform neutron spectrum and criticality homogeneous reactor code based on the B-1 approximation with extended Greuling-Goertzel slowing down. Input data requirements were formulated that permit flexibility in the choice of physical approximations applied in homogenizing heterogeneous reactor lattices. A thermal neutron energy group is included. Input data for this are given explicitly. Special attention was devoted to calculation of resonance absorption and resonance fission processes. All fundamental nuclear data are contained in a cross section library. Output is extensive and includes a.o. multigroup neutron spectra, leakage and slowing down spectra, element-wise absorption and fission rates, and few group diffusion constants. (auth)

34731 (NASA-CR-54110) EXPERIMENTAL NEUTRON FLUX DISTRIBUTIONS IN A WATER SYSTEM WITH AN INTERNAL CAVITY. Final Report. Floro Miraldi, David A. McBride, and George W. Nelson (Case Inst. of Tech., Cleveland). June 30, 1964. Contract NAS-3-3213. 70p.

Neutron flux distributions were measured in a system consisting of a large spherical cavity in water. Neutrons were provided by a Pu–Be source located at the center of the cavity. Three cavity geometries were studied including concentric spheres. Cavity fillings were air at one atmosphere and BF_3 at various pressures between one and three atmospheres. Measurements were made by foil activation. Foil activation distributions are presented, and relative thermal flux distributions are compared to Fermi-age and two-group diffusion theory. Results show that the flux distributions in the cavity regions are quite flat. Comparisons of theory and experiment indicates that the simple calculations performed are insufficient to describe these systems. (auth)

34732 (WAPD-TM-436) EMPIRE-1 AND EMPIRE-2, FORTRAN MULTIGROUP DISCRETE ORDINATE TRANSPORT CODES TO SOLVE SLAB GEOMETRIES. J. D. Butler (Westinghouse Electric Co. Bettis Atomic Power Lab., Pittsburgh). Apr. 1964. Contract AT(11-1)-Gen-14. 45p.

EMPIRE-1 (MO466) and EMPIRE-2 (MO498) are FORTRAN segmented programs which solve the multigroup neutron transport problem with slowing down in slab geometry via a discrete ordinate approximation. The programs handle up to 200 groups with anisotropic scattering up to 10 terms and compute up to 10 terms in the angular expansion of the flux at each point in each group. Integrated results in terms of such things as pointwise isotopic absorption rates and regionwise isotopic capture fractions are also provided. EMPIRE-2 also calculates pointwise slowing-down densities past the last group. (auth)

34733 SPECTRA OF SLOW NEUTRONS IN WATER WITH ABSORBERS. N. I. Laletin. At. Energ. (USSR), 16: 402-7(May 1964). (In Russian)

Results are given of calculations of slow neutron spectra in water with boron, cadmium, and samarium. The spectra are calculated using a previously derived differential equation, functions obtained from the model of variable effective mass and the constants $\xi\sigma_s$ = const., γ = 1 being taken as usable functions to characterize the energy exchange of the neutron with the medium. Results are compared with experimental data, with calculated curves obtained for the gas model with mass = 1 in the heavy gas approximation, and with curves obtained with the Nelkin nucleus. It appears that the variable effective mass model unsatisfactorily describes neutron spectra in water; the use of the functions $\xi\sigma_s$ = const., γ = 1 gives results much closer to experimental values. These results differ insignificantly from those obtained from the Nelkin nucleus and represent a better approximation than that given by the gas model. (tr-auth)

34734 THERMAL PARAMETERS AND NEUTRON SPECTRA IN ORGANIC MODERATORS. V. C. Boffi, B. Marsico, V. G. Molinari, R. Scozzafava, and G. Traversa (CNEN, Rome). Energia Nucl. (Milan), 11: 297-307(June 1964).

Some calculations of thermal parameters and nuclear spectra in organic moderators using the bound hydrogen and free-gas scattering kernels are outlined. The effects of the chemical binding on the organic moderated reactor design calculations are also considered. Comparisons are made with experimental results. (auth)

34735 MEASUREMENTS OF DEVIATION FROM 1/E DISTRIBUTION IN EPI-CADMIUM NEUTRON SPECTRUM. Kazuhiko Inoue (Japan Atomic Energy Research Inst., Tokyo) and Kenji Katori. J. Nucl. Sci. Technol. (Tokyo), 1: 1-6(Apr. 1964).

An approach to the representation of the reaction rate of the epicadmium energy neutron is presented, and a characteristic parameter defining the deviation from the 1/E shape is introduced. This parameter is useful in studying the spatial dependence of epi-cadmium neutron spectra in thermal reactors. It is shown that a ^{235}U fission detector is one of the best detectors for this purpose. The measurement involved was performed by using a ^{235}U fission counter in the SHE critical assembly. The experimental results obtained are compared with theoretical results in good agreement. (auth)

34736 A STOCHASTIC METHOD OF CALCULATING SECOND SPATIAL MOMENT OF NEUTRON DISTRIBUTION IN HYDROGENOUS MODERATORS. Tamotsu Sekiya (Osaka Univ.), Tokuo Suita, and Hirokazu Murase. J. Nucl. Sci. Technol. (Tokyo), 1: 7-10(Apr. 1964).

The second spatial moment is calculated by a stochastic method for the case of isotropic and homogeneous moderators. Formulas are obtained for the slowing down length and migration area. The results for the slowing down length coincide with that of Volkin, and the expression for the migration area contains coherence terms between the slowing-down and diffusion processes. (auth)

34737 NEUTRON SELF-SHIELDING FACTOR OF SCATTERING-PREDOMINANT RESONANCE FOILS. Takashi Nakayama and Hideo Kuroi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 68-72(May 1964).

The neutron self-shielding factor of ^{59}Co resonance foil was obtained by both Monte Carlo method (analog) and the collision probability method for various foil thicknesses. Also, the transmission and reflection probabilities of neutrons which have various energies near the resonance energy were obtained. The effects of multiple scattering of neutrons on the neutron self-shielding factor are discussed, and the results obtained by the two methods are compared. (auth)

34738 PULSED NEUTRON EXPERIMENT IN FAST NATURAL URANIUM SYSTEMS. Toru Hiraoka, Tsutomu Iijima, Naohiro Hirakawa, Tomoo Nakamura, and Masao Nozawa (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 108-9(June 1964).

A series of pulsed neutron experiments for fast neutrons of nanosecond order was performed for the non-multiplying and multiplying systems of natural uranium. The distinctive differences between the two systems are illustrated. The behavior of the decay curves of each energy group was investigated. The calculated energy spectrum in the systems show rather good agreement with experimental results. (C.E.S.)

34739 NEUTRON SCATTERING BY WATER TAKING INTO ACCOUNT THE ANISOTROPY OF THE MOLECULAR VIBRATIONS. Juan U. Koppel and James A. Young (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 19: 412-17(Aug. 1964). (GA-4850)

A scattering kernel was obtained for H_2O which takes into account the anisotropic nature of the molecular vibrations, in contrast to the isotropic nature of the Nelkin kernel. Detailed comparison of both models shows that the anisotropic model gives 5 to 7% better agreement with experiment. (auth)

34740 INELASTIC SCATTERING OF 2- TO 5-Mev NEUTRONS BY IRON. J. C. Hopkins and M. G. Silbert (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 19: 431-6(Aug. 1964). (LADC-6162)

The cross sections for neutron inelastic scattering to the various levels of natural iron were measured for incident neutron energies between 2 and 5 Mev at a laboratory angle of 50°. Scattered neutrons were observed directly with a time-of-flight neutron spectrometer. The cross sections for iron were measured relative to the cross section for neutron scattering from hydrogen. (auth)

34741 EVALUATION OF RESONANCE INTEGRALS IN HOMOGENEOUS AND HETEROGENEOUS SYSTEMS—AN INTERMEDIATE APPROXIMATION. Guido Forti (CNEN, Rome). Nucl. Sci. Eng., 19: 449-57(Aug. 1964).

A theoretical approximation, which bridges the gap between NR and NRIA approximations for resonance integrals,

is derived using the concept of escape probability in energy space for a single line. The method is applied to the heterogeneous case. Numerical calculations, neglecting interference scattering lead to simple fitting formulas for UO_2 and ThO_2 rods at different temperatures; the calculations are in good agreement with experiment. (auth)

34742 SOME EXACT EXPRESSIONS FOR THE MONOENERGETIC NEUTRON DIFFUSION LENGTH. J. J. McInerney (Pennsylvania State Univ., University Park). Nucl. Sci. Eng., 19: 458-60(Aug. 1964).

Some exact expressions for the diffusion length are found using a set of eigenfunctions recently derived for the monoenergetic neutron transport equation. The results are not restricted to any specific degree of anisotropy and are valid for an arbitrary amount of absorption in the medium. A closed-form solution is found for the roots of the equation $cL \tanh^{-1}(1/L) = 1$. (auth)

34743 ON THE TRANSPORT EQUATION IN PLANE GEOMETRY. George J. Mitsis (Argonne National Lab., Ill.). Nucl. Sci. Eng., 19: 466-8(Aug. 1964).

It is shown that the stationary, monoenergetic transport equation, under the restrictions of plane symmetry and isotropic scattering, is equivalent to a singular integral equation with the space variable appearing as a parameter. (D.C.W.)

34744 EFFECTIVE SURFACE IN LATTICES IN THE CALCULATION OF RESONANCE INTEGRALS. H. Aisu (Mitsubishi Atomic Power Industries, Omiya, Japan and Westinghouse Electric Corp., Pittsburgh) and G. H. Minton. Nucl. Sci. Eng., 19: 468-71(Aug. 1964).

A relation obtained by Levine between the effective fuel surface and the Dancoff factor is discussed in connection with an investigation of the Bell approximation for the escape probability in both slab and square lattices. It is concluded that the relation is suitable for calculating the Doppler correction to the Dancoff factor for square and hexagonal lattices for the normal absorber radius. (D.C.W.)

34745 SPATIAL-DISTRIBUTION FUNCTIONS FOR CALCULATING NEUTRON DENSITIES BY MONTE CARLO. Harvey J. Amster and Wilson K. Talley (Univ. of California, Davis). Nucl. Sci. Eng., 20: 53-9(Sept. 1964).

When describing neutrons interacting with homogeneous media, Monte Carlo can generate a sequence of energies and flight directions without locating the positions of the collisions that produced them. If the spatial distribution of one of these collisions is then described analytically, unbiased direct samples of the neutron density can conveniently be obtained at specified positions and energies and at discretely sampled angles. Previous applications for plane sources in infinite media with real cross sections are generalized for plane sources in slabs and point sources within infinite half spaces. A modified treatment for heterogeneous media is also formulated. (auth)

34746 THE MILNE PROBLEM IN A FINITE DOMAIN. I. ISOTROPIC SCATTERING. F. A. Hinchey, E. A. Dean, and J. B. Pearce (New Mexico State Univ., University Park). Nucl. Sci. Eng., 20: 88-92(Sept. 1964).

An approximate solution of the Milne problem in a finite slab for isotropic elastic scattering in non-absorbing medium is investigated. The problem may be formulated as an integral equation of the Wiener-Hopf type with a finite range of integration. A solution of this integral equation is obtained by the use of finite Fourier transforms, which lead to an infinite system of linear algebraic equations. A highly convergent iterative solution for the truncated system of equations is developed. Numerical results are presented for several slab thicknesses in the case of normal illumination. (auth)

34747 A THEOREM CONCERNING THE SLOWING-DOWN EQUATION. M. W. Dyos (Australian Atomic Energy Commission, Sutherland, New South Wales). Nucl. Sci. Eng., 20: 111-14(Sept. 1964).

A relation between the source and any scattering kernel is established for which the solution of the slowing-down equation is a constant for all lethargies. (D.C.W.)

34748 CALCULATION OF THE SCATTERING FUNCTION $S(k,\omega)$ FOR THE INELASTIC SCATTERING OF NEUTRONS BY ANHARMONIC CRYSTALS. A. A. Maradudin (Westinghouse Electric Corp., Pittsburgh) and V. Ambegaokar. Phys. Rev., 135: A1071-80(Aug. 17, 1964).

A numerical calculation is presented of van Hove's scattering function $S(k,\omega)$, which describes the inelastic scattering of neutrons by an anharmonic crystal with the transfer of momentum k and energy ω from neutron to crystal. Two contributions to $S(k,\omega)$ are included in the present calculation: the leading term which describes the broadening and shift of the one-phonon peak, and the leading term which describes the interference between the one-phonon peak and the diffuse multiphonon background. The calculations of $S(k,\omega)$ as a function of ω for fixed k are carried out in the high-temperature limit for a nearest-neighbor, central-force model of a face-centered cubic crystal which is chosen to approximate lead. The ω dependence of the phonon frequency shift and width, as well as of the coefficient of the interference term, is taken into account in these calculations. In the cases treated the interference terms represent only a very small correction to the one-phonon peak, in agreement with a previous crude estimate by Ambegaokar, Conway, and Baym. (auth)

34749 PULSED NEUTRON GENERATOR WITH HIGH VACUUM AND CONTROL GRID BETWEEN ION SOURCE AND TARGET. Barney J. Carr (to Kaman Aircraft Corp.). U. S. Patent 3,141,975. July 21, 1964. Filed Jan. 12, 1960.

A vacuum-sealed, continuously-pumped, portable neutron source with an output of about 10^7 n/4-μsec pulse and a pulse rate greater than 10/sec is described. (D.C.W.)

Nuclear Properties and Reactions

Refer also to abstracts 33676, 33926, 33932, and 34538.

34750 (AWRE-O-30/64) NEUTRON CROSS SECTIONS OF U-236 IN THE ENERGY RANGE 1 kev–15 Mev. K. Parker (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). July 1964. 45p.

Recommended values are given for neutron total and partial cross sections of ^{236}U in the energy range 1 kev to 15 Mev. The available experimental evidence is supplemented by estimates based on nuclear systematics. Details of energy and angular distributions are given so that the data are complete for the purpose of neutron calculations. The values given are available on punched cards (2/U-236 data, nuclide identification number (NIN) = 173) as part of the UKAEA Nuclear Data Library. Literature references to data at neutron energies below 1 kev are given to facilitate extension of the data to lower energies at some later date. (auth)

34751 (CONF-481-71) TIME-OF-FLIGHT MEASUREMENTS MADE WITH NEUTRONS FROM NUCLEAR EX-

PLOSIONS IN SPACE. S. J. Bame (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 29p.

From the American Physical Society Annual Meeting, New York, Jan. 1964.

Results of measurements of neutron energy spectra from the 1962 high-altitude test series are given. Secondary results in the resonance structure of various nuclides are discussed. (R.E.U.)

34752 (CU(PNPL)-234) PROGRESS REPORT FOR JANUARY 1963 TO JANUARY 1964 TO THE UNITED STATES ATOMIC ENERGY COMMISSION. (Columbia Univ., New York. Pegram Nuclear Physics Labs.). Contract AT(30-1)-Gen-72. 182p.

Studies are reported of: neutron resonance absorption parameters of As and Br; neutron fission and alpha decay of ^{235}U; cross sections for $^{32}S(d,p)$; cross sections for (p,γ) on ^{23}Na, ^{11}B, and ^{39}K; proton inelastic scattering by ^{25}Mg and ^{26}Mg; the theory of beta decay for various nuclei; measurements of angular correlations and lifetimes for nuclear transitions; detection of two-photon $0^+ - 0^+$ transitions in ^{90}Zr and ^{40}Ca; determinations of positron annihilation rates in various media; analysis of neutron scattering, thermalization, diffusion, and reactions in various media; and the design and development of nuclear and other instrumentation. (T.F.H.)

34753 (EANDC(E)-50(L)) STATUS REPORT ON CROSS-SECTION MEASUREMENTS OF NEUTRON-INDUCED THRESHOLD REACTIONS. A. Paulsen and H. Liskien (European Atomic Energy Community. Central Nuclear Measurements Bureau, Geel, Belgium). May 1964. 9p.

Requests for information on neutron cross section measurements for threshold detectors are compared with published measurements. Discrepancy or agreement between two or more series of measurements has been taken into account for establishing the valuation. (T.F.H.)

34754 (HMI-B-35) ZUR THEORIE NIEDERENERGETISCHER KERNREAKTIONEN. (On the Theory of Low-Energy Nuclear Reactions). H. A. Weidenmueller (Hahn-Meitner-Institut für Kernforschung, Berlin). May 1964. 157p.

Simple potential scattering was studied in order to introduce some basic concepts used in complicated cases of nuclear reactions. Multichannel scattering, which is the model for all nuclear reactions, is then considered. The optical model and direct interactions are described. (J.S.R.)

34755 (IDO-16880-1) SCINTILLATION SPECTROMETRY. GAMMA-RAY SPECTRUM CATALOGUE. 2nd Edition. Volume 1 of 2. R. L. Heath (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Aug. 1964. Contract AT(10-1)-205. 365p.

This edition of the Scintillation Spectrometry Gamma-ray Spectrum Catalog is a complete revision of the original data compilation, which was issued as IDO-16408 in 1958. As in the original catalog, this edition contains a collection of spectra representing the response of a scintillation spectrometer to individual radioactive nuclides. In addition to the graphs representing the response of a 3" × 3" NaI detector in a standard geometrical arrangement, the data are presented in digital form for the preparation of punched-card, perforated tape, or magnetic tape libraries for data analysis. An important edition to the catalog is data for neutron-deficient isotopes. The new edition is prepared in two loose-leaf volumes and contains data for almost 300 isotopes. All spectra are normalized to a standard set of gain scales and a text is presented that describes the fundamentals of gamma spectrometry. This includes a discussion of spectrometer design, electronics, instrumental calibration, and data processing. To facilitate the use of these data, tables of detector efficiency, photopeak efficiency, and other information useful for quantitative data analysis are included. An extensive index was also added with separate tables of data listed according to gamma-ray energy, half life, method of source production, and other specialized categories. For volume II, see IDO-16880-2. (auth)

34756 (IDO-16880-2) SCINTILLATION SPECTROMETRY. GAMMA-RAY SPECTRUM CATALOGUE. 2nd Edition. Volume 2 of 2. R. L. Heath (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Aug. 1964. Contract AT(10-1)-205. 285p.

34757 (INSJ-72) NUMERICAL DIFFERENTIAL CROSS SECTIONS OF THE REACTION $^{40}Ca(p,d)^{39}Ca$ AT 55 Mev. Yoshio Saji, Eiji Tanaka, Kohsuke Yagi, Hiroyasu Ejiri, Yoshihide Ishizaki, Masahiro Koike, Kazuhisa Matsuda, Yutaka Nakajima, and Itaru Nonaka (Tokyo Univ. Inst. for Nuclear Study). Apr. 22, 1964. 10p.

The angular distributions of deuterons were studied using a proportional counter system associated with a plastic scintillator coincidence system and a magnetic analyzer. Differential cross sections are given for 3 to 65° (cms) for protons of 55 Mev (lab.). (R.E.U.)

34758 (JEN-130-DF/I-41) INTERACIONES DE DEUTERONES DE ENERGÍAS MEDIAS SOBRE UN BLANCO DE ^{51}V. (Interactions of Low-Energy Deuterons with a Target of ^{51}V). R. Diez Gonzalez (Spain. Junta de Energia Nuclear, Madrid). 1964. 22p.

A study of $^{51}V(d,d)^{51}V$ elastic scattering was carried out for beam energies of 8.01, 8.47, 8.97, 9.44, 9.94, and 10.46 Mev, using the A.W.R.E. multichannel magnetic spectrograph. From a Fraunhofer analysis of the $\sigma_E(\alpha)/\sigma_R(\alpha)$ ratio, the corresponding black disk interaction radii were calculated. The angular distributions were analyzed on the basis of the optical model to find the values of the corresponding parameters and their variations with the beam energy. The elastic scattering of deuterons by ^{16}O, present in target as contaminant, was studied from the similar point of view of angular distributions, Fraunhofer analysis, and optical model analysis. (auth)

34759 (JINR-D-1963) THE FORMATION OF SPONTANEOUSLY FISSIONING ISOMER IN THE CAPTURE OF NEUTRONS BY Am. A. F. Linev, B. N. Markov, A. A. Pleve, and S. M. Polikanov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1964. 7p.

The formation of a spontaneously fissioning isomer ($T_{½}$ = 13.1 ± 1.0 msec) was observed during the irradiation of ^{243}Am with 14-Mev neutrons. The cross section for the reaction is about 1.5×10^{-28} cm^2. The results of this work together with the data previously obtained (preprint P-1299, Dubna 1963) lead to the conclusion that in this case an isotope of ^{242}Am in an isomeric state was spontaneously fissioning. (auth)

34760 (JINR-E-1696) STRUCTURE OF THE EXCITED STATES WITH $K\pi = 2+$ OF EVEN-EVEN DEFORMED NUCLEI. V. G. Soloviev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 8p.

The energies of two most low-lying $K\pi = 2+$ states of even-even nuclei in the regions $150 < A < 190$ and $228 \leq A \leq 254$ were calculated with account of the blocking effect. Good agreement between theory and experiment was obtained. The structure of these states was investigated. Within the framework of the superfluid nuclear model, the

two-quasiparticle and collective nonrotational excited states of even-even deformed nuclei are uniquely described. It is shown that the average field of the nucleus determines which of the states are collective and which are the quasiparticle ones. (auth)

34761 (JINR-E-1703) PROBABILITIES OF ELECTROMAGNETIC TRANSITIONS FROM COLLECTIVE TO GROUND STATES OF EVEN-EVEN STRONGLY DEFORMED NUCLEI. P. Vogel (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 9p.

The reduced probabilities of electromagnetic transitions of the E3, E2, and E1 types are calculated using the method of approximate second quantization in the superfluid model of atomic nuclei. The quantities B(E2) are calculated for transitions between γ-vibrational and ground states, and B(E3) and B(E1) for octupole states. A comparison with experiments shows that the considered model gives a good explanation of the experimental data for transitions between one phonon states and the phonon vacuum. (auth)

34762 (JINR-P-1671) O SVYAZI MEZHDY DLINOI RASSEYANIYA I SECHENIEM PADIATSIONNOGO ZAKHVATA NEITRONOV. (On a Relationship Between Scattering Length and the Cross Section for Neutron Radiative Capture). Yu. I. Fenin and F. L. Shapiro (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Neutron Physics). 1964. 4p.

Using the formal theory of nuclear reactions, a formula is derived that relates the cross section for the neutron radiative capture with the energy derivative of the scattering length. This formula may be applied to obtain the radiation widths or the cross section for the radiative neutron capture from the known scattering cross sections. (auth)

34763 (JINR-P-1675) UGLOVOE RASPREDELENIE PRODUKTOV REAKTSII MUL'TINUKLONNOI PEREDACHI. (The Angular Distribution of Products of Multinucleon Transfer Reactions). Ya. Grabovskii, B. N. Kalinkin, and N. F. Markova (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 20p.

The quasiclassical theory of multinucleon transfer reactions is given. It is shown that contrary to the one-nucleon transfer in these reactions, it is necessary to take into account their inelastic character. (auth)

34764 (JINR-P-1678) MEKHANIZM VZAIMODEISTVIYA KOSMICHESKIKH CHASTITS BOL'TSOI ENERGII S ATOMNYMI YADRAMI. (Interaction Mechanism of High-Energy Cosmic Particles with Atomic Nuclei). V. S. Barashenkov and S. M. Eliseev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 19p.

The Monte Carlo method is used to calculate the intranuclear cascades initiated by nucleons with an energy T ≈ (100 to 1000) Bev. Within experimental errors the results agree with available experimental data. Thus, in a large energy region of some dozens of Mev to several hundreds of Bev, the interaction of particles with atomic nuclei goes mainly via successive interactions with separate nucleons of the nucleus. (auth)

34765 (JINR-P-1679) OB EKSPERIMENTAL'NOI POPYTKE OBNARUZHENIYA DVUPROTONNOGO RASPADA. (An Experimental Attempt to Detect Ne^{16} Two-Proton Decay). V. A. Karnaukhov and Si-tin Lu (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 6p.

The experiments on the search for two-proton radioactivity are described. A Ni target was bombarded with ^{20}Ne ions at 150 Mev. Special equipment was used to detect ^{16}Ne (a possible emitter of two protons) produced by the four-neutron transfer reaction. No case of two-proton decay was observed. This result can be explained in two ways: (1) The cross section for ^{16}Ne production is less than or equal to 1.8×10^{-30} cm^2 (in the case of E_{pp}, the energy of two-proton decay, exceeding 1 Mev, and the half life time being not less than 10^{-8} sec); (2) The half life time for ^{16}Ne is less than 10^{-8} sec. (auth)

34766 (JINR-P-1687) ISSLEDOVANIE α-SPEKTRA IZOTOPOV TERBIYA. (Investigation of the α-Spectrum of Terbium Isotopes). K. Ya. Gromov, I. Makhunka, M. Makhunka, and T. Fenesh (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 12p.

The α spectra of the terbium isotopes produced by bombarding tantalum target with 660-Mev protons were studied. The measurements were made by means of a semiconductor α spectrometer. The results of measurements are tabulated. (auth)

34767 (JINR-P-1706) O PROTONNOM RASPADE YADER X Z > 50. (On Proton Decay of Nuclei with Z > 50). V. A. Karnaukhov and G. M. Ter-Akopyan (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1964. 11p.

The probability of proton decay of nuclei with Z > 50 is discussed. This kind of radioactivity including the emission of delayed protons as well as proton decay from the ground state should be a rather spread phenomenon among the neutron-deficient isotopes of all elements up to bismuth. A notable competition on the part of alpha radioactivity can be displayed only for nuclei with proton or neutron numbers a little higher than magic numbers 50 and 82. As Z of the nucleus is increased, the proton binding energy gradually depends upon the mass number. Therefore, for each element heavier than Sb, from 2 to 4 isotopes unstable for proton emission from the ground state and having the measurable half life (10^{-1} to 10^{-10} sec) can be observed. Among the elements with odd Z the following are referred to this series: Sb, I, Cs, La, Pr, Pm, Eu, Tb, Ho, Tm, Lu, Ta, Re, Ir, Au, and Tl. The majority of these isotopes could be obtained from the parent nuclei with even Z in the results of β^+ decay, which considerably simplifies the experiment. Several nuclear reactions with heavy ions that allow to get these isotopes are given. The probability of α decay is sharply increased for elements heavier than Pb. However, even in this region up to Bk the proton decay from the ground state with half life 10^{-5} to 10^{-10} sec is possible. (auth)

34768 (MIT-2098-61) INTERMEDIATE RESONANCES AND DOORWAY STATES. H. Feshbach, A. K. Kerman, and R. H. Lemmer (Massachusetts Inst. of Tech., Cambridge and Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Aug. 4, 1964. Contract AT(30-1)-2098. 6p. (CONF-502-18)

From International Congress of Nuclear Physics, Paris, July 1964.

A formal description of intermediate resonance structure in average cross sections is discussed. It is shown that the width of an intermediate resonance consists of an escape width plus a damping width down into the compound nucleus. A formula for the damping width is derived. (auth)

34769 (NP-14085) ETUDE DES REACTIONS (n,α) A L'AIDE D'UN MODELE D'INTERACTION DIRECTE (these). (Study of (n,α) Reactions by Means of a Direct Interaction Model (thesis)). Jean-Noel Massot (Lyon. Université). [1963]. 109p.

The reactions X(n,α)Z are studied by adopting the formalism of the direct interaction. Two types of possible processes are distinguished. In the first—the pickup process—the target is decomposed into an inert core not participating in the reaction and a group of nucleons corresponding to ^{3}He that would be captured by the incident neutron. The second—the knockout process—was obtained by considering the target to be made up of a core plus a ^{4}He, for which the α particle is then expelled from the nucleus by the neutron. From the ensemble of these two phenomena, the angular distribution is found. The results obtained are applied to the study of the reactions ^{16}O(n,α)^{13}C and ^{23}Na(n,α)^{20}F and compared with experimental results for incident neutrons of 14 Mev. (tr-auth)

34770 (NP-14115) NOUVELLE MÉTHODE POUR DÉTERMINER LA VIE MOYENNE DES ÉTATS INSTABLES DE RADIOÉLÉMENTS A FILIATION (THESES). (New Method for Determining the Mean Life of Unstable States of Daughters of Radioelements (thesis)). Gilbert Landaud (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 60p.

Submitted to Caen, France. Université.

A method for the measurement of the mean life based on the analysis of a correlation function characteristic of the element studied is proposed. After a systematic study of the variances of different statistical models, the uncertainty function X(t) = ±1 was selected as the theoretical basis of the method. The principle of the measurement of the correlation function of X(t) = ±1 is derived, and the apparatus used for the experimental testing of the method is described. The statistical fluctuation of the experimental value of the correlation coefficient is calculated. The systematic errors possible were detected. Excited states of ^{181}Ta and ^{75}As were measured, and the results discussed. The correlation method is compared with the method of delayed coincidences. (J.S.R.)

34771 (NP-14175) SOME INTERACTIONS OF DEUTERONS WITH ISOTOPES OF HYDROGEN AND HELIUM. Willem Theodorus Hendricus van Oers (Amsterdam. Instituut voor Kernphysisch Onderzoek). 1963. 95p.

Thesis submitted to Universiteit, Amsterdam.

The differential cross section for elastic scattering of 24.85-Mev deuterons by ^{4}He was measured by observing both elastically scattered deuterons and the recoil alpha particles. The angular distribution shows a similar behavior to those found at lower energies except in the region around 60° where a new relative maximum in the cross section appears. Energy spectra of protons from the reaction d + p → p + p + n with E_d = 24.35 Mev were measured as function of angle. The angular region for observing protons is limited by kinematics to angles smaller than 58°. After conversion to the center-of-mass system the shapes of the energy spectra show similar behavior in comparison with the spectra obtained in measurements at other energies. The estimated total cross section for emission of protons in the forward hemisphere, which is equivalent to the backward hemisphere when protons are impinging with half the energy, is 230 mb. The differential cross section for elastic scattering of 25.3-Mev deuterons by deuterons was measured for center-of-mass scattering angles between 13.95 and 97.4°. Elastically scattered deuterons were detected with a counter telescope used in conjunction with a particle identification circuit to provide the necessary separation of proton, deuteron, and triton pulse height spectra. In this arrangement ^{3}He particles were not recorded. Measurements were repeated for a group of center-of-mass scattering angles smaller than 33° using a single scintillator. In this case aluminum absorbers were used to obtain the separation of the group of elastically scattered deuterons from the ^{3}He and triton groups. The angular distribution does not show a Coulomb-nuclear interference minimum in the region of small angles. A small relative maximum in the cross section arises around 90°. The differential cross sections of the mirror reactions D(d,n)^{3}He and D(d,p)T were measured at 25.3 ± 0.3 Mev incident deuteron energy. The angular distributions of the two reactions are practically identical except possibly at very small angles. The D(d,n)^{3}He cross section was fitted using the Butler-Born approximation stripping theory. This reaction was also considered in terms of a general rearrangement collision formalism. A Legendre polynomial expansion of the reaction amplitudes was found in which higher order expansion coefficients are obtained in the Born approximation while the lower order coefficients are treated as free parameters determined by fitting the experimental cross section. (auth)

34772 (NP-14184) LIFETIMES OF NUCLEAR EXCITED STATES MEASURED WITH THE DELAYED COINCIDENCE METHOD. (thesis). Thijs Johannes de Boer (Amsterdam. Vrije Universiteit). 1963. 71p.

The measurement of the lifetimes of first excited states of even-even nuclei is discussed. The choice of a method of measurement is discussed: delayed coincidence was chosen. The evaluation of data from these measurements is described, and results are given for ^{102}Ru, ^{126}Xe, ^{192}Pt, ^{196}Hg, ^{160}Dy, ^{164}Er, ^{166}Er, and ^{180}W. A gamma detector made of a combination of a NaI(Tl) crystal and a plastic scintillator is described that retains good energy resolution in fast coincidence measurements. (R.E.U.)

34773 (NP-14190) ANTISYMMETRIZATION OF A UNIFIED NUCLEAR REACTION THEORY. [PART] II. Technical Report No. 337. W. M. MacDonald (Paris. Université, Orsay. Laboratoire Joliot-Curie de Physique Nucléaire and Maryland. Univ., College Park). Nov. 1963. 19p.

A completely antisymmetrized version of the unified nuclear reaction theory given previously is developed by using a theorem due to Brenig. The theory leads naturally to a shell model description of compound nuclear states. (auth)

34774 (ORNL-P-144) SOME APPLICATIONS OF THE DISTORTED WAVE APPROXIMATION FOR DIRECT NUCLEAR REACTIONS. R. H. Bassel (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 84p.

The distorted-wave theory of direct reactions and its application to the study of nuclei are discussed. The reaction theory, its range of validity, and its ability to give quantitative information about nuclear structure are considered. The distorted-wave matrix element is derived. The theory is formulated in a general way so that rearrangement collisions such as stripping and inelastic scattering appear on the same footing. The theory is compared with experimental results for the ^{40}Ca(d,p), Ca(d,p), ^{56}Fe(p,d), ^{114}Cd(d,p), ^{40}Ca(d,d), and ^{16}O(n,d) reactions and ^{12}C inelastic scattering by ^{12}C and ^{16}O. (C.E.S.)

34775 (TID-20875) THE CORIOLIS ANTI-PAIRING AND THE BLOCKING EFFECTS IN DEFORMED EVEN-EVEN NUCLEI. Technical Report No. 372. Amand Faessler (Freiburg I. B. Universitat); Walter Greiner (Maryland. Univ., College Park); and Raymond K. Sheline (Florida State Univ., Tallahassee). Apr. 1964. Contracts AT(40-1)-2434 and Nonr-1797(00). 26p.

The additional effects of the Coriolis anti-pairing and

blocking on the second order rotational vibrational hamiltonian are discussed for even-even nuclei. This leads to lower limits on the pairing correlation energy (W_0) and the critical spin I_c introduced by Mottelson and Valatin. Typical lower limits deduced from presently available experimental data are $W_0 = 2-3$ Mev and $I_c = 24$ (^{186}Os) and 50 (^{238}U). The blocking constant, τ, deduced from experiment is in agreement with the theoretical estimate. (auth)

34776 (UCRL-11004) MEASUREMENTS OF THE MUON-CAPTURE RATE IN He^3 AND He^4 (thesis). Robert John Esterling (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 9, 1964. Contract W-7405-eng-48. 169p.

A measurement was made of the total muon-capture rates in ^{3}He and ^{4}He and the partial capture rate into the channel $\mu^- + {}^3\text{He} \rightarrow {}^3\text{H} + \nu$. Negative muons were brought to rest in a high-pressure helium gas target. The capture processes all yield a charged particle whose energy was measured by observation of scintillation in the helium gas. Captures into the ^{3}H channel were recognized by the unique energy (1.9 Mev) of the triton recoil. The total capture rates obtained were: $\Lambda(^3\text{He}) = 2170$ sec^{-1} and $\Lambda(^4\text{He}) = 375$ sec^{-1}. The partial capture rate to the triton ground state was measured as $\Lambda(^3\text{He} \rightarrow {}^3\text{H}) = 1505 \pm 46$ sec^{-1}. The results are in good agreement with theoretical predictions that are based on the universal Fermi interaction. (auth)

34777 (UCRL-11238) ISOMERISM IN $_{85}At^{212}$ (thesis). W. Barclay Jones (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 3, 1964. Contract W-7405-eng-48. 84p.

Experiments are reported on the study of $^{209}\text{Bi}(\alpha,n)^{212}\text{At}$ for alpha energies from 15 to 26 Mev. Isomers of ^{212}At were found with half lives of 0.118 and 0.305 sec decaying to ^{208}Bi by alpha emission with alpha energies of (7.66, 7.60 Mev) and (7.88, 7.82 Mev). The energy-level assignments and the half life schematics are discussed in terms of the shell model. The excitation functions were measured and are correlated to compound-nuclear theory. (auth)

34778 (UCRL-11338) STUDIES IN THE LIQUID-DROP THEORY OF NUCLEAR FISSION (thesis). James Rayford Nix (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1, 1964. Contract W-7405-eng-48. 235p.

In connection with nuclear fission the division of an idealized charged drop was studied using a simplified version of the liquid-drop model. The degrees of freedom essential to a discussion of the division of a charged drop and the separation of the fragments to infinity are taken into account: a fragment-separation coordinate, a mass-asymmetry coordinate, a deformation coordinate for each fragment, and rotational coordinates for each fragment. To specify fragment deformation, the fragments are represented by spheroids; a nucleus prior to division is represented by two overlapping spheroids. The hamiltonian for the idealized system consists of a sum of surface, Coulomb, and kinetic energies. A study of the saddle-point energies and shapes calculated in this two-spheroid approximation indicates that the approximation is most useful for discussing the fission of elements lighter than about radium. On the basis of this model, probability distributions are calculated for certain observable characteristics of fission fragments at infinity—their total translational kinetic energy, mass, individual excitation energies, and individual angular momenta. This is done by applying standard static, dynamical, and statistical methods to the hamiltonian for the system. The treatment, for the most part, is classical; quantum mechanics is considered only in the statistical-mechanics discussion of the behavior of the system near the saddle point. The predictions of the model are compared with existing experimental data for distributions in fragment mass and total translational kinetic energy, for nuclei lighter than radium. The comparisons are made without the use of any adjustable parameters. The theory is capable of accounting for the magnitudes of the most probable values and widths of the experimental distributions, as well as some, but not all, finer details of the distributions. The dependence of the experimental distributions upon nuclear temperature, and the dependence of the experimental most probable kinetic energies upon fissionability parameter are also approximately reproduced by the calculations. (auth)

34779 (UCRL-11341) INVESTIGATION OF HIGHLY POPULATED LEVELS OF THE $(d_{5/2})^2_{5/2}$ AND $(f_{7/2})^2_{7/2}$ CONFIGURATIONS BY THE (α,d) REACTION (thesis). Ernest Jean-Marie Rivet (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 24, 1964. Contract W-7405-eng-48. 116p.

The (α,d) reaction was observed on ^{12}C, ^{14}N, ^{15}N, ^{16}O, ^{20}Ne, ^{24}Mg, ^{32}S, ^{40}Ar, and ^{40}Ca. This reaction was induced by the 48-Mev α-particle beam 60-inch cyclotron, and by the 45- and 50-Mev beams of the 88-inch variable-energy cyclotron. All the deuteron energy spectra obtained were dominated by one or more highly populated states called the gross structure levels. Evidence that these levels have a common configuration is obtained from the remarkable similarity of their angular distributions, and the relation between their Q values of formation and the atomic-mass number of the recoil nuclei. In the assumption of a direct interaction, it is proposed that the levels preferentially populated are of the $[J_T + (J_p J_n)_{J'}]_J$ configuration, where the proton and the neutron couple their spin to J', which in turn couples with the angular momentum of the target to give the final state J. It is also shown that the proton-neutron pair is captured in the $d_{5/2}$ or $f_{7/2}$ shell of the recoil nucleus investigated, and that the maximum final spin (5 or 7) is favored. The $(^3\text{He},p)$ reaction was observed on ^{12}C and ^{16}O, and, as expected, the levels highly populated in the (α,d) reactions were once again preferentially populated. The scattering of α particles from ^{14}N and ^{16}O was also investigated to confirm the two-nucleus nature of the highly populated levels formed by two-nucleon transfer reactions. The monotonically decreasing pattern of the angular distributions of these gross-structure levels is explained in terms of increasing momentum mismatch. (auth)

34780 (UCRL-11349) CHARGED-PARTICLE EMISSION IN HEAVY-ION INTERACTIONS (thesis). Donald V. Reames (California. Univ., Berkeley. Lawrence Radiation Lab.). May 11, 1964. Contract W-7405-eng-48. 49p.

Light charged particles produced at 0 deg in the interaction of 167-Mev ^{16}O ions with Al, Ni, Ag, and Au thick targets were analyzed magnetically with nuclear emulsion as a detector. The spectra obtained are compared with statistical-model calculations, which include the effects of angular momentum and multiple emission. The spectra from light targets are seen to be sensitive to the equilibrium shape of the compound nucleus, since rotational effects that depend on this shape are large for these nuclei. For ^{16}O on Au the de-excitation of the compound nucleus is found to be dominated by neutron emission, and a comparison of the calculations with neutron spectra seems to show that the nucleus fissions with highest probability after about 5 ± 1 stages of neutron emission. Owing to the increased competition of neutron emission, the charged-particle

yields for the heavier elements decrease until they are dominated by direct reaction products. These products, particularly the Li isotopes, are seen to arise from a breakup of the incident ^{16}O, and the energetics of this process are considered. (auth)

34781 (UCRL-11376) NUCLEAR STRUCTURE CALCULATIONS FOR DEFORMED NUCLEI. K. Dietrich (University of Southern California, Los Angeles); H-J. Mang (California. Univ., Berkeley. Lawrence Radiation Lab.); and J. Pradal (Paris. Université, Orsay. Institut du Radium). Apr. 1964. Contract W-7405-eng-48. 7p. (CONF-502-14)

From International Congress of Nuclear Physics, Paris, July 1964.

The generalized Hartree-Fock method is applied to a calculation of equilibrium deformations of ^{24}Mg and neighboring nuclei. A nucleon-nucleon potential of Gaussian shape and Serber exchange character is used. The quadrupole moments obtained agree reasonably with the measured values. The Nilsson potential turns out to be a rather good approximation to the self-consistent field. (auth)

34782 (UCRL-11563) RECOIL STUDIES OF NUCLEAR REACTIONS OF Ir, Bi AND Pb^{208} WITH O^{16} (thesis). Paul D. Croft (California. Univ., Berkeley. Lawrence Radiation Lab.). July 20, 1964. Contract W-7405-eng-48. 90p.

Range-energy curves for 6- to 12-Mev At and Po recoils in Al leaf and Al_2O_3 were determined using nuclear reactions of ^{16}O with Ir to produce the recoils. Al leaf foils of ~0.15 mg/cm^2 and Al_2O_3 foils of 0.07 mg/cm^2 were used. Ranges in mg/cm^2 are 7 to 11% larger in Al_2O_3 than in Al. The range-energy curves obtained were compared with theoretical predictions and used to transform measured ranges for Po, At, Rn, and Fr into recoil energies. Projected range distributions in stacked Al_2O_3 foils were determined for the α-active products from the reactions $^{209}Bi(^{16}O,X)Y$ at various bombarding energies from 76 to 163 Mev and $^{208}Pb(^{16}O,X)Y$ at 123 and 163 Mev. The products, Y, identified were $^{206,208,210}Po$, $^{209,211}At$, $^{210,211,212}Rn$, and ^{212}Fr. The nature of X could be exactly specified only for the Bi bombardments near the coulomb barrier where the results indicate that ^{210}Po and ^{211}At are formed by p and 2p transfers, with the residual ^{15}N and ^{14}C being ejected in a preferentially backward direction. These processes give the recoils energies and ranges up to about 3 times the values possible from a compound-nucleus reaction. For both Pb and Bi targets at bombarding energies above about 1.3 times the coulomb barrier, the range distributions for the products generally peak at ranges from one-quarter to one-half the compound nucleus range, but most have a long-range tail. With the help of angular distribution experiments, it was possible to clarify in a qualitative way the mechanisms at the higher energies. No evidence was obtained which indicates that α transfer might be a preferred mode. (auth)

34783 (ORNL-tr-235) A STUDY OF THE ENERGIES OF ELECTRONS AND POSITRONS EMITTED AT THE TIME OF CERTAIN NUCLEAR REACTIONS. M. Claude Magnan. Translated by Joe F. Allen (Oak Ridge National Lab., Tenn.), from Compt. Rend., 205: 1147-9(1937). 5p.

The positron energy spectra from ^{22}Na, ^{26}Al, and ^{30}P were studied. (R.E.U.)

34784 AN INVESTIGATION OF THE $K^{39}(p,\gamma)Ca^{40}$ REACTION AT PROTON ENERGIES 1103 kev, 1131 kev, AND 1153 kev. L. Simons, E. Spring, L. Kaeld, H. Jungner, P. Holmberg, and I. Forsblom (Univ. of Helsinki). Acta Polytech. Scand., Phys. Nucl. Ser., No. 29, 1-19(1964).

A study was made of the gamma spectra of the resonances at proton energies 1103, 1131, and 1153 kev in the $^{39}K(p,\gamma)$ ^{40}Ca reaction, and the main decay features are given. Evidence was found supporting the existence of a new ^{40}Ca level, with an energy at about 4.70 Mev. Measurement was made of the angular distribution of the 9.44-Mev gamma ray de-exciting the 1131-kev resonance level. The spin and parity of this resonance level is probably 1^+ or 1^-. (auth)

34785 ON THE MEAN BETA DISINTEGRATION ENERGIES OF Pr^{143}, S^{35}, AND Pm^{147}. Vaeinoe Hovi, Lasse Niemelae, and Jorma Varonen (Univ. of Turku, Finland). Ann. Acad. Sci. Fennicae, Ser. A VI, 150: 1-12(1964).

By using an isothermal microcalorimetric method and radioactive beta sources, the mean beta disintegration energies of ^{143}Pr and ^{35}S were measured at liquid nitrogen temperature. The activity of these sources was known with a great accuracy. The measured values of the mean beta disintegration energy, 310 and 48.8 kev for ^{143}Pr and ^{35}S, respectively, are in very good agreement with those obtained from Fermi's theory and from experimental beta spectra. The mean beta disintegration energies of ^{35}S and ^{147}Pm were also determined by means of a scintillation spectrometer in which an anthracene split-crystal was used. (auth)

34786 CONTRIBUTION TO THE STUDY OF LOW-ENERGY ELECTRON SPECTRA. PARTS II AND III. Jose Sant'ana Dionisio. Ann. Phys. (Paris) (13), 9: 29-71 (Jan.-Feb. 1964). (In French)

The classical method of semi-circular magnetic focusing with and without pre-acceleration for the study of low energy electron spectra is reviewed. Spectrography, source preparation and electron detection in electron spectrography, and spectrograph calibration are discussed. Typical data on the K, L, and M Auger spectra and Coster-Krönig spectra are tabulated to show their complexity and indicate the difficulties in obtaining the spectra. Experimental data are given on the conversion electron spectra emitted during the transmutations $Au^{191} \rightarrow Pt^{191} \rightarrow Ir^{191}$, $Hg^{193} \rightarrow Au^{193} \rightarrow Pt^{193}$, $Hg^{195} \rightarrow Au^{195}$, $Pb^{212} \rightarrow Bi^{212} \rightarrow Tl^{208}$, and $Pb^{214} \rightarrow Bi^{214} \rightarrow Po^{214}$ and the isomeric transitions of Hg^{193m} and Hg^{195m}. (J.S.R.)

34787 THE EFFECT OF A NON-AXIAL SYMMETRICAL NUCLEAR DEFORMATION ON THE PATTERN OF THE s-WAVE NEUTRON INTENSITY FUNCTION. R. Reif (Central Inst. of Nuclear Research, Rossendorf, Ger.). Ann. Physik (7), 13: 1-8(Mar. 1964). (In German)

The Davydov-Filippov theory shows that in calculations in the phenomological optical model for a series of nuclei, a non-axially symmetric deformed potential must be introduced. In order to estimate the effect of the non-axiality on the pattern of the s-wave intensity function, the problem of the scattering of slow neutrons on the non-axially symmetric deformed box potential was solved in the adiabatic approximation. An additional splitting (in comparison with the axially symmetric case) of the maximum of the intensity function lying at A ~ 150 for a spherical potential was shown at not too low equilibrium deformation for sufficiently strong deviation from axial symmetry. (tr-auth)

34788 THE K AUGER EFFECT IN Br^{79}. P. Erman, E. C. O. Bonacalza, and J. Rossi (Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 26: 35-44(1964).

The Auger effect in ^{79}Br was studied in detail using an extremely thin ^{79}Kr source produced in an electromagnetic isotope separator furnished with an ion-retardation device. The energies and relative intensities of the KLL compo-

nents are determined and compared to theoretical values. The KLM components are analyzed and the relative group intensities KLL:KLX:KXY are established. (auth)

34789 THE K AUGER GROUP INTENSITIES IN Cl^{37}. P. Erman, J. Rossi, E. C. O. Bonacalza, and J. Miskel (Nobel Inst. of Physics, Stockholm and Univ. of California, Livermore). Arkiv Fysik, 26: 135-40(1964).

The K Auger group intensities have been measured in the decay of ^{37}Ar to ^{37}Cl. The measured KLL:KLX:KXY intensities are $1:0.156 \pm 0.010:0.009 \pm 0.001$. These data are compared with corresponding results for higher Z-values obtained by other authors and with the theory of Geffrion and Nadeau. (auth)

34790 SEARCH FOR VIBRATIONAL LEVELS IN Br^{79}. E. C. O. Bonacalza (Nobel Inst. of Physics, Stockholm and Royal Inst. of Tech., Stockholm). Arkiv Fysik, 26: 141-52 (1964).

Single and coincidence gamma spectra as well as conversion electron spectra were studied in the decay of ^{79}Kr. The level scheme of ^{79}Br has been well established. Five new transitions with energies 1336, 1119, 1074, 1028, and 936 kev were found. They de-excite a new level at 1336 kev in ^{79}Br. Through these high energy transitions the position of the low energy levels is ascertained. Relative electron and gamma intensities and estimates of K conversion coefficients are given. Limited spin alternatives are proposed for all levels. The 307 kev level is thought to be due mainly to quadrupole vibration. On the other hand the 217 and 261 kev levels should correspond to quasi-particle levels, whereas the present experimental situation does not allow any definite conclusions about the levels at 398, 606, 836 kev, and on the new level at 1336 kev. The log ft values for the feeding to different states are established. The maximum energy of the positron spectrum is found to be (613 ± 5) kev. The half life of ^{79}Kr is determined to be (34.92 ± 0.05) h. (auth)

34791 NEW ENERGY LEVELS IN K^{37}. S. E. Arnell (Chalmers Tekniska Högskola, Goteborg). Arkiv Fysik, 26: 153-9(1964).

Electromagnetically separated ^{36}Ar targets were bombarded with protons in the energy range 700 kev to 4.0 Mev. A new level in ^{37}K with an excitation energy of 2.73 Mev was found by a p,γ-reaction. The probable spin assignment of this level is $\frac{5}{2}^+$. Several resonances were also found by observing the gamma radiation arising from the $^{36}Ar(p,p',\gamma)^{36}Ar$ reaction. (auth)

34792 THE $Fe^{56}(p,\gamma)Co^{57}$ REACTION. S. E. Arnell and P. O. Persson (Chalmers Tekniska Hogskola, Goteborg). Arkiv Fysik, 26: 193-207(1964).

The $^{56}Fe(p,\gamma)^{57}Co$ reaction was studied up to a proton energy of 1400 kev. From a study of some resonances found, several new levels in ^{57}Co are proposed. (auth)

34793 ENERGY LEVELS OF Mn^{51}. S. E. Arnell and S. Sterner (Chalmers Tekniska Högskola, Goteborg). Arkiv Fysik, 26: 309-18(1964).

The gamma decay of some resonances in the reaction $^{50}Cr(p,\gamma)^{51}Mn$ was studied using scintillation spectrometry. A tentative level scheme of ^{51}Mn is given, including excited states at the following energies: 0.22 ± 0.05, 1.80 ± 0.02, 1.94 ± 0.02, 2.12 ± 0.03, 2.72 ± 0.03, 2.36 ± 0.03, 2.65 ± 0.04, 2.84 ± 0.03, 2.94 ± 0.04, 3.01 ± 0.04, and 3.81 ± 0.05 Mev. (auth)

34794 THE ELECTROMAGNETIC PROPERTIES OF LEVELS AND TRANSITIONS IN THE GROUND STATE ROTATIONAL BAND OF Tm 169. T. Sundstroem, J. Lindskog, J. O. Lindstroem, and P. Sparrman (Uppsala Univ.). Arkiv Fysik, 26: 361-76(1964).

The experimental data for the electromagnetic properties of the ground state rotational band of ^{169}Tm are reviewed and discussed in terms of the unified nuclear model. (auth)

34795 A MEASUREMENT OF THE LIFETIME OF THE 138.9 kev LEVEL IN Tm 169. T. Sundstroem, P. Sparrman, J. O. Lindstroem, and J. Lindskog (Uppsala Univ.). Arkiv Fysik, 26: 377-81(1964).

The lifetime of the 138.9-kev, $\frac{7}{2}^+$ level in ^{169}Tm was measured to be 321 ± 14 psec by the delayed coincidence technique. (auth)

34796 TWO LIFETIMES IN THE GROUND STATE ROTATIONAL BAND OF Tm 171. T. Sundstroem, J. O. Lindstroem, P. Sparrman, and J. Lindskog (Uppsala Univ.). Arkiv Fysik, 26: 397-405(1964).

The lifetimes of two states in the ground state rotational band of ^{171}Tm were measured by the delayed coincidence method. The results are 55 ± 13 and 362 ± 15 psec for the 116.7-kev, $\frac{5}{2}^+$ and 129.1-kev, $\frac{7}{2}^+$ levels, respectively. The results are compared with the corresponding data for the very similar rotational states in ^{169}Tm and are discussed with regard to the unified nuclear model. (auth)

34797 AN INVESTIGATION OF THE $Cr^{52}(p,\gamma)Mn^{53}$ REACTION. S. E. Arnell and S. Sterner (Chalmers Tekniska Hogskola, Goteborg). Arkiv Fysik, 26: 423-38 (1964).

The gamma decay of some resonances in the reaction $^{52}Cr(p,\gamma)^{53}Mn$ was studied. New levels in ^{53}Mn are suggested at the following energies: 2.26 ± 0.05, 2.41 ± 0.03, 2.66 ± 0.03, 2.81 ± 0.05, 2.85 ± 0.03, and 3.20 ± 0.05 Mev. (auth)

34798 LOW-ENERGY GAMMA TRANSITIONS IN ^{238}Pu AND ^{240}Pu. G. G. Akalaev, N. A. Vartanov, and P. S. Samoilov. At. Energ. (USSR), 16: 452-3(May 1964). (In Russian)

A study was made of the electron and gamma spectra of a mixture of curium isotopes in a magnetic beta spectrometer with double focusing and in a scintillation gamma spectrometer. Spectral line intensity, electron energy, conversion shell, transition energy, and relative line intensity are presented for lines in the electron spectrum of ^{238}Pu and ^{240}Pu, formed in the alpha decay of ^{242}Cm and ^{244}Cm. The ratios of coefficients of internal conversion in E2 transitions with energies 43 and 44 kev for Z = 94 are derived and compared with those from two other experiments and from theoretical calculations. (M.J.T.)

34799 NUCLEAR PHYSICAL EXPERIMENTS WITH NEUTRON BEAMS. G. van Middelkoop. Atoomenergie Haar Teopassingen, 6: 89-99(May 1964). (In Dutch)

A review is given of some nuclear physical experiments with neutron beams. The β decay of the neutron, particle reactions, and capture reactions are described. Beam experiments performed at the Petten high flux reactor using the horizontal beam are reported. (tr-auth)

34800 A METHOD FOR MEASURING RELATIVE DISINTEGRATION INTENSITY AND ANGULAR MOMENTA IN RADIOACTIVE DECAY SCHEMES. F. Demichelis and F. Iachello (Instituto di Fisica Sperimentale del Politecnico, Turin). Atti Acad. Sci. Torino, Pt. I, Classe Sci. Fis. Mat. Nat., 98(1963/64), 50-60(1964). (In Italian)

A method is described for determining the angular momenta and parities of excited states, while also obtaining the relative intensities of the gamma rays associated with each separate decay path. The method is particularly

applicable for decay schemes in which two gamma rays with about the same energy can not be resolved through the detector. (D.C.W.)

34801 EXCHANGE CONTRIBUTION TO ELASTIC SCATTERING OF α PARTICLES BY LIGHT NUCLEI. C. Quesne and C. Willain (Université Libre, Brussels). Bull. Classe Sci., Acad. Roy. Belg. (5), 49: 1156-64(1963). (In French)

The differential cross section for elastic scattering of alpha particles by light nuclei described by the alpha model was calculated in the plane-wave Born approximation. Be^8 was treated as an example. When the range of interaction between alpha particles was zero, the contribution of the heavy-particle stripping mode was very small in relation to those of the direct and knock-out processes, producing forward peaking of the total differential cross section. (D.C.W.)

34802 LOW-ENERGY GAMMA-RAY TRANSITIONS IN Np^{237} FOLLOWING α DECAY OF Am^{241}. J. L. Wolfson and J. J. H. Park (National Research Council, Ottawa). Can. J. Phys., 42: 1387-1410(July 1964). (NRC-7960)

The low-energy gamma transitions in ^{237}Np following α decay of ^{241}Am were studied by examination of the internal conversion spectrum at good resolution. Improved measurements of the energies and intensities of the lines due to the well-known transitions of energies 26.36, 33.21, 43.44, 55.56, 59.57, and 99.00 kev were made. The existence of a weak transition of energy 67.52 kev was confirmed. The existence of weak transitions of energies 27, 42.8, 70, and 76 kev, previously reported, was not substantiated. For the 43.44-kev transition, the L subshell ratios L_I/L_{III} and L_{II}/L_{III} are in disagreement as to the proportion of E2 component in the M1, E2 mixture assigned to this radiation, while the M subshell ratios are in disagreement with both L subshell ratios. The binding energies of the L, M, and N subshells in Np were measured. All values are slightly higher than those found by extrapolation from values at lower Z, although the values are in agreement with such extrapolations within experimental uncertainty. (auth)

34803 MEASUREMENTS OF THE HALF LIVES OF THE ENERGY LEVELS OF PROTACTINIUM-234 DE-EXCITED BY 63- AND 93-Kev γ TRANSITIONS. Hussein Abou-Leila (Laboratoire Joliot-Curie, Orsay, France). Compt. Rend., 258: 5632-5(June 8, 1964). (In French)

The half lives for the 63- and 93-kev γ emission by ^{234}Pa were found to be $T_{1/2}$ (63 kev) = $5.5 \pm 1 \times 10^{-10}$ sec and $T_{1/2}$ (93 kev) $\leq 10^{-10}$ sec. (tr-auth)

34804 THE LOW-ENERGY ELECTRON SPECTRUM EMITTED DURING THE TRANSMUTATIONS OF TUNGSTEN-189 INTO RHENIUM-187. Claire Sebille and Francois Widemann. Compt. Rend., 258: 5636-9(June 8, 1964). (In French)

The LXY Auger-electron and internal-conversion-electron spectra emitted during the beta decay $^{187}W \rightarrow ^{187}Re$ were studied using a pre-acceleration semi-circular magnetic spectrograph. The existence of three new radiations, one of which was the 72-kev K-conversion radiation, was established. (tr-auth)

34805 DECAY OF Re^{186}. L. Malý, Z. Plajner, and J. Jursik (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Czech. J. Phys., 14: 240-6(1964).

The decay of ^{186}Re was investigated with a double-focusing spectrometer and a scintillation spectrometer. Four transitions were observed with energies of 122.7 ± 0.1, 137.2, 632.2 ± 1.5, and 768.2 ± 1.5 kev and relative gamma intensities 18, 246, 0.9, and 1, respectively. The K-conversion coefficients determined for low-energy transitions are in good agreement with the theoretical values. The relative intensities of the K, L, M, and N conversion lines were also determined for these transitions: $K : L_{I+II} : L_{III} : M = 1.20 \pm 0.20 : 1.32 \pm 0.20 : 1 \pm 0.15 : 0.57 \pm 0.08$ for the 122.7-kev transition, $K : L_{I+II} : L_{III} : M : N = 1.57 \pm 0.08 : 1.72 \pm 0.08 : 0.70 \pm 0.03 : 0.20 \pm 0.01$ for the 137.2-kev transition. In the beta spectrum two groups were observed with the end points of 1076 ± 3 and 939 ± 3 kev and relative intensities of 74 ± 4 and 21 ± 4%, respectively. For the branching of K-capture it was found that 1.5% populates the 122.7 kev level and 3.5% the ground state. A decay scheme is proposed. (auth)

34806 ON THE OCCURRENCE OF GAMMA-RADIATION AT THE INTERACTION OF DEUTERONS AND Li. J. Juna and K. Konečný (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Czech. J. Phys., 14: 275-6(1964).

The maximum gamma energy produced in the $^7Li(d,n)^8Be$ reaction was estimated to be 480 to 500 kev from the time-of-flight spectrum for the reaction. The emission was attributed to the first excited level of $^7Li^*$; a 4.9-Mev gamma line previously observed and attributed to $^8Be^*$ was not in evidence. (D.C.W.)

34807 TRANSFORMATION MATRIX FOR THE ISOTROPIC HARMONIC OSCILLATOR EIGENVECTORS IN $\{n_1n_2n_3\}$ AND $\{nlm\}$-REPRESENTATIONS. Z. Pluhař and J. Tolar (Czech Technical Univ., Prague). Czech. J. Phys., 14: 287-93(1964).

The properties of the elements $\langle n_1n_2n_3|nlm\rangle$ of the transformation matrix connecting the eigenvectors $|n_1n_2n_3\rangle$ and $|nlm\rangle$ of the isotropic harmonic oscillator are investigated. An explicit expression and recursion relations for these elements are derived. (auth)

34808 $O^+ \longrightarrow O^-$ BETA TRANSITIONS. M. Vinduška (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Czech. J. Phys., 14: 393-403(1964). (In Russian)

The reasons for similarity between first-forbidden and allowed beta transitions are investigated. The shape of beta spectra, the degree of longitudinal polarization, and lg-ft values are considered in the particular case ($O^+ \longrightarrow O^-$). The results of analyses are used for comparison of the consequences of the conserved vector current with experimental data. It is shown, that CVC is not in contradiction with the data. (auth)

34809 POLARIZATION MEASUREMENTS WITH 6.7 Mev PROTONS SCATTERED ON CARBON. P. Bém, J. Habanec, O. Karban, J. Němec, V. Presperin (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řez). Czech. J. Phys., 14: 404-10(1964). (In Russian)

A carbon polarimeter for proton polarization measurements at energies higher than 4 Mev was designed. Considerable transmission was obtained by using a thick polarimeter target and larger scattering solid angles. The effective polarization value in the proton energy range from 4.6 to 6.0 Mev varies only slightly with energy and attains an average value of ~ -0.8. The angular distribution of polarized protons scattered elastically from carbon at 6.7 Mev and at angles from 30 to 120° was measured. The distribution has two minima and one maximum. (auth)

34810 ANALYSIS OF THE (n,α) NUCLEAR REACTIONS. E. Saetta Menichella (Laboratori CISE, Milan), F. Tonolini, and L. Tonolini Severgnini. Energia Nucl. (Milan), 11: 324-36(June 1964). (In Italian)

Experimental data on (n,α) reactions, particularly at

14 Mev, are reviewed and analyzed by statistical model formulas. (D.C.W.)

34811 "DOUBLE EMISSION OF HEAVY FRAGMENTS ($Z \geq 3$) IN THE DISINTEGRATION OF EMULSION NUCLEI." G. C. Deka and K. M. Pathak (Cotton Coll., Assam, India). Indian J. Phys., 38: 7-9(Jan. 1964).

Among 405 "hammer" tracks observed in the interactions of 4.6-Bev/c mesons (π^-) with heavy emulsion nuclei, twelve events involving either two "hammer" tracks or one "hammer" and a heavy fragment ($Z \geq 3$) were found. The heavy fragments appear to be emitted independently during the evaporation process. (D.C.W.)

34812 ON NUCLEAR BINDING ENERGIES. A. K. Dutta, B. Pal, P. Ganguly, and D. Banerjee (Univ. of Calcutta). Indian J. Phys., 38: 57-60(Jan. 1964).

Relations for the binding energies of nuclei of a given mass number were derived. Experimental and calculated binding energies for all the isobars of some mass numbers are tabulated. (D.C.W.)

34813 ABSOLUTE MEASUREMENTS OF THE DISINTEGRATION RATES OF AMERICIUM-241 SOURCES BY USING SEMICONDUCTOR DETECTORS. Eiji Sakai, Hiroyuki Tamura, and Yoshifumi Sakurai (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 101-9(June 1964).

Low geometry α counting and α-particle/γ-ray coincidence counting were made to determine the absolute disintegration rate of an ^{241}Am source. Alpha particles were counted by silicon junction detectors and γ rays by an NaI(Tl) crystal-photomultiplier system. The half life of the 60-kev level of ^{237}Np was measured to check the effect of the coincidence resolving time in the absolute measurement of the americium source by α-γ coincidence counting; the half life measured was 6.3×10^{-8} sec. The mean value of the absolute disintegration rate of a typical ^{241}Am source measured by coincidence counting was 1.696×10^4 dps and the 90% confidence interval for the mean value was $\langle 1.679 \times 10^4, 1.713 \times 10^4$ dps$\rangle$. Accurate absolute measurements by low geometry α particle counting are very difficult especially for very small semiconductor detectors because of the difficulty of measuring the accurate geometries. (auth)

34814 2^+ STATES OF ^{16}O WITH T = 0. P. Camiz and N. Vinh Mau (Service de Physique Theorique, Orsay, France). J. Phys. (Paris), 25: 371-3(Apr. 1964). (In French)

The 2^+, T = 0 levels of ^{16}O were studied under the assumption that an excited state can be obtained by excitation, of one hole-particle pair and also by excitation of two hole-particle pairs. The wave function of the lowest 2^+ state was then used to calculate the de-excitation probability from this state to the first 0^+ excited state and the ground state. (auth)

34815 ANISOTROPY FACTORS FOR THE DETERMINATION OF TOTAL NEUTRON YIELD FROM THE D(d,n)He^3 AND T(d,n)He^4 REACTIONS. L. Ruby and R. B. Crawford (Univ. of California, Berkeley). Nucl. Instr. Methods, 24: 413-17(1963). (UCRL-10752)

Tables were computed of the anisotropy factor, R, which is useful in determining, by the associated particle method, the total neutron yield produced in the reactions T(d,n)^{4}He and D(d,n)^{3}He. The range of incident deuteron energy covered is 25 to 500 kev, at associated particle colatitude angles of 90 to 180 deg. Thick- and thin-target cases were treated. For the T(d,n)^{4}He reaction, the total neutrons produced per alpha particle incident on the detector is given by the relation, $N = (4\pi/\Delta\Phi)R$. In the case of the D(d,n)^{3}He reaction, it is more convenient to detect the protons produced in the competing reaction D(d,p)T. The total neutrons per proton incident on the detector is then given by $N = (4\pi/\Delta\Omega)R(Y_{d,n}/Y_{d,p})$, where $(Y_{d,n}/Y_{d,p})$ is the ratio of total neutrons to total protons produced. Tables of this ratio, of R, and of their product are given. (auth)

34816 DISTORTED WAVE EFFECTS AND THE IMPULSE APPROXIMATION IN THE INELASTIC SCATTERING OF 147 Mev PROTONS FROM ^{12}C. D. J. Rowe, G. L. Salmon, A. B. Clegg, and D. Newton (Oxford Univ.). Nucl. Phys., 54: 193-220(May 1964).

The angular correlations of scattered protons and gamma rays in the inelastic scattering of 147-Mev protons from the first excited state of ^{12}C were measured. The measurements were analyzed using the impulse approximation. The adiabatic approximation was used so that distorted wave effects can be taken into account. The scattering is predominantly no-spin-flip, and the no-spin-flip matrix elements are found to behave in the manner expected. In particular, the extra terms introduced on going from the plane-wave angular correlation to the distorted-wave angular correlation are small. Spin-flip scattering was measured; and, for proton scattering angles $\geq 25°$, this process is weak and of the magnitude expected. However, at a scattering angle of 15° the spin-flip scattering is unexpectedly strong. As an interpretation of this, it is suggested that a nucleon in the fringe of the nucleus can more easily have its spin flipped in this inelastic scattering than a nucleon in the bulk of the nucleus. The interference between no-spin-flip and spin-flip was measured. The measurements are used to check the assumption that the scattering of a proton from a nucleon bound in the nucleus is the same as the scattering from a free nucleon. This assumption succeeds for scattering angles <35°, but fails for scattering through 45°, the largest momentum transfer studied. A similar conclusion is reached in an analysis of previous measurements of the polarization of the proton from this inelastic scattering. It is suggested that this may be due to a change in the p-N scattering on going off the energy shell. (auth)

34817 CONVERSION ELECTRONS IN THE DECAY OF Ag^{106m} TO Pd^{106}. W. Scheuer (Comisión Nacional de Energía Atómica, Buenos Aires), T. Suter, P. Reyes-Suter, and E. Aasa. Nucl. Phys., 54: 221-4(May 1964).

The internal conversion spectrum in the decay of ^{106m}Ag to ^{106}Pd was obtained using an iron-yoke, double-focusing spectrometer. Transitions of the following energies were determined with an accuracy of about 5×10^{-4}: 195.0, 221.5, 228.5, 328.3, 390.9, 406.0, 429.5, 450.8, 474.2, 511.8, 600.9, 616.1, 680.3, 703.3, 716.2, 717.1, 748.3, 792.8, 803.9, 807.5, 824.5, 847.5, 1045.7, 1127.8, 1199.1, and 1222.8 kev. (auth)

34818 A NEW FIRST EXCITED STATE OF P^{31} AT 450 kev DETECTED BY MEANS OF THE PICK-UP REACTION ON S^{32}. L. Colli (Università, Milan and CISE, Milan), P. Forti, and E. Gadioli. Nucl. Phys., 54: 253-6(May 1964).

The spectrum of deuterons resulting from the bombardment of ^{32}S with 14-Mev neutrons was measured. Evidence was found for a state at 450 ± 100 kev in ^{31}P. The angular distributions of the deuteron groups suggest spin ½ for the ground state and for the 450-kev state. The results are discussed in terms of the Nilsson model. (auth)

34819 STUDY OF THE REACTION IN TWO STATES ^{6}Li(^{6}Li,α)^{8}Be*.^{8}Be* = 2α. J. L. Quebert (Faculté des Sciences, Bordeaux), M. Coste, and L. Marquez. Nucl. Phys., 54: 257-64(May 1964). (In French)

The spectrum of alpha particles from the reaction was measured at several angles using nuclear plates. The

spectrum shows the same shape and has the same intensity in all directions. It was shown that, under very plausible assumptions, the first reaction is isotropic. The shape of the experimental spectrum can be quantitatively explained if the second reaction is assumed to be isotropic. It is found that the intermediate state is a level of ^{8}Be at about 22 Mev, having a width of about 0.4 Mev. (auth)

34820 MONO-ENERGETIC POSITRON EMISSION IN THE DECAY OF ^{152}Eu. Sakae Shimizu, Yasuyuki Nakayama, Haruyoshi Hirata, and Hiromasa Mazaki (Kyoto Univ.). Nucl. Phys., 54: 265-77(May 1964).

The monoenergetic positron emission of the 1409-kev E1 transition in ^{152}Sm was measured using a Siegbahn-Slätis, intermediate-image spectrometer. By comparing the intensity of the positron peak with that of the internal conversion line of the same transition the branching ratio for this process was determined to be $2.5 \pm 1.0 \times 10^{-7}$ positron/gamma transition, in reasonable agreement with that reported by Perdrisat. The mean life of the 1531-kev level of ^{152}Sm was estimated to be 5.7×10^{-15} sec. From the experimental value and relative transition intensities, it is found that the 1409-kev E1 transition is retarded, when compared with the single-proton transition probability, by a factor of at least about 60. (auth)

34821 ENERGY LEVELS OF Na^{22} FROM THE $Mg^{25}(p,\alpha)Na^{22}$ REACTION. L. G. Lawrence (Australian National Univ., Canberra). Nucl. Phys., 54: 295-300(May 1964).

An investigation of the ^{25}Mg(p,α)^{22}Na reaction with 9-Mev protons gave evidence for a level of ^{22}Na at 655.5 ± 2.0 kev. The data suggest the possibility of a further level at 1.9 Mev, which could be the missing second T = 1 level. Alpha particles to the known 2.22-Mev level of ^{22}Na are absent or very weak. (auth)

34822 ENERGY LEVELS OF THE Si^{28} NUCLEUS. Y. P. Antoufiev, O. E. Badawy, L. M. El-Nadi, D. A. E. Darwish, and P. V. Sorokin (Atomic Energy Establishment, Cairo). Nucl. Phys., 54: 301-14(May 1964).

Angular correlation studies of (p,γ), (p,$\alpha\gamma$), and (p,2γ) on ^{27}Al established the spin and parity for ten levels in the ^{28}Si nucleus corresponding to resonance proton capture at E_p = 0.992 Mev (3^+), 1.025 Mev (3^+), 1.184 Mev (2^+), 1.198 Mev (3^+), 1.212 Mev (3^-), 1.261 Mev (3^-), 1.316 Mev (3^- or 4^+), 1.355 Mev (3^-), 1.514 Mev (2^-), and 1.589 Mev (3^-). One of the doublet levels at 6.88 Mev was found to have spin and parity 2^-. The partial widths, strengths of radiative transitions and the reduced transition strengths for the gamma rays leading to the first excited state were estimated in order to test the validity of the isobaric spin selection rule. (auth)

34823 THE REACTION $Al^{27}(d,\alpha)Mg^{25}$ IN THE DEUTERON ENERGY RANGE 1.5–2.6 Mev. M. A. Abuzeid, Y. P. Antoufiev, A. T. Baranik, M. I. El-Zaiki, T. M. Nower, and P. V. Sorokin (Atomic Energy Establishment, Cairo). Nucl. Phys., 54: 315-20(May 1964).

Excitation functions for the reaction ^{27}Al(d,α)^{25}Mg and angular distributions of ten alpha groups were measured. It is shown that the intensities of alpha groups averaged over the energy range 1.5–2.6 Mev and the interval of angles 90–150° follow the 2I + 1 law. The maximum deviation does not exceed 20%. The root-mean-square deviation is 10%. (auth)

34824 PARTICLE-HOLE DESCRIPTION OF CARBON 12 AND OXYGEN 16. Vincent Gillet (CEN, Saclay, France) and Nicole Vinh Mau. Nucl. Phys., 54: 321-51 (May 1964).

The states of ^{12}C and ^{16}O are computed in the framework of the particle-hole model of nuclear excitations, using a finite range force with an exchange mixture determined by a least square fit. The particle-hole energies are obtained from the spectra of the neighboring odd-mass nuclei, in the hypothesis of a spherical scheme and of pure j-j coupling. The results given by the Elliot and Flowers procedure and the random phase approximation are compared. The parametric behavior of the areas of strong discrepancies is delimited. An overall good agreement with the odd-parity states of ^{16}O is reached. In the case of ^{12}C, while reproducing many features of its spectrum, close agreement with forces consistent with the spherical stability of the nucleus is not obtained. (auth)

34825 THE EXCITATION OF LEVELS OF N^{14} BY INELASTIC ELECTRON SCATTERING. G. R. Bishop, M. Bernheim, and P. Kossanyi-Demay (École Normale Supérieure, Orsay, France). Nucl. Phys., 54: 353-68 (June 1964).

The cross sections for electron elastic and inelastic scattering by ^{14}N were measured. A number of inelastic peaks appear in the spectra which are attributed to scattering with excitation of the levels of ^{14}N. The electric or magnetic multipole order of the corresponding transitions was determined from the dependence of the inelastic form factor on scattering angle and momentum transfer. Besides leading to partial reduced transition probabilities the results indicate the nature of the dominant configurations forming the excited states which were studied. The results are compared with theoretical predictions. (auth)

34826 MANY-NUCLEON SYSTEM IN THE SHELL-MODEL POTENTIAL. I. M. Band, Yu. I. Kharitonov, and L. A. Sliv (Inst. of Physics and Tech., Leningrad). Nucl. Phys., 54: 369-92(June 1964).

A quantal description is given of a system of a large number of nucleons moving in a shell-model potential with residual pairing forces acting between them. Expressions for the matrix elements are obtained, and their dependence on the number of nucleons is investigated. It is shown that the transition from spherical to deformed nuclei is a structural effect determined by the n-n and p-p interaction. A detailed calculation is made of the spectrum of the ^{218}Rn nucleus. The binding energy of ten outer nucleons in ^{218}Rn proves to be in good agreement with experiment. The latter result shows that the residual forces are in the main pairing forces. (auth)

34827 COMPARISON OF THE (n,γ) AND (d,p) REACTIONS IN COBALT. H. U. Gersch, W. Rudolph, and K. F. Alexander (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Nucl. Phys., 54: 405-13(June 1964). (In German)

Neutron capture gamma rays from the reaction ^{59}Co(n,γ)^{60}Co were measured using a magnetic Compton spectrometer. Better resolution (1%) and precision of the determination of the high-energy gamma transitions was achieved, the error of the energy determination of the excited levels being 2 to 6 kev. This permits an unambiguous identification with the (d,p) levels. There is a correspondence between strong transitions observed in the (n,γ) reaction and strong transitions in the (d,p) reaction for low-lying levels with orbital momentum l_n = 1. However, there are further intense (n,γ) transitions to a group of levels in a region 2 Mev above the ground state, for which no correspondence to strong (d,p) transitions is found. The possibilities of associating collective properties with these levels is discussed. (auth)

34828 OPTICAL MODEL ANALYSIS OF THE ELASTIC SCATTERING OF 1-Mev NEUTRONS. R. N. Maddison (Sheffield Univ., Eng.). Nucl. Phys., 54: 417-33(June 1964).

The differential cross sections for elastic scattering of 0.98-Mev neutrons by twenty elements, including ten rare earths, were analyzed by a least squares process for various optical model assumptions. The validity of the model (particularly for deformed nuclei), the possibility of distinguishing between surface and volume absorption, variations of the parameters with mass number, and the accuracy and number of parameters were investigated. (D.C.W.)

34829 A STUDY OF THE GAMMA RADIATION PRODUCED IN THE ALPHA-PARTICLE BOMBARDMENT OF O^{16}. J. D. Pearson and R. H. Spear (California Inst. of Tech., Pasadena). Nucl. Phys., 54: 434-64(June 1964).

The excitation function for gamma radiation from the reaction $^{16}O(\alpha,\gamma)^{20}Ne$ was obtained for laboratory alpha energies E_α from 4.8 to 9.9 Mev. Resonances were observed at E_α = 5.374, 5.94, 6.61, 6.930, 7.94, 8.17, 8.54, and 9.40 Mev, corresponding to ^{20}Ne states at excitation energies E_x of 9.029, 9.48, 10.02, 10.270, 11.08, 11.27, 11.56, and 12.25 Mev. Gamma angular distribution measurements established spins and parities of 4^+ and 2^+ for the 9.029 and 10.270 Mev states, respectively, and indicate that the 11.08 Mev state is probably 4^+. The 2^+ assignment for the 10.270-Mev state is supported by the results of triple angular correlation studies of the gamma cascade through the 1.63 Mev state. Decay schemes were investigated, and estimates were made of radiative widths and total widths. It is concluded that the 10.270-Mev state is the first T = 1 state of ^{20}Ne, on the basis of measurements of its excitation energy, spin and parity, total width, and M1 radiative width. The excitation function for 6.13 Mev gamma rays from the reaction $^{16}O(\alpha,\alpha'\gamma)^{16}O$ was studied for E_α from 8.9 to 9.9 Mev. The data clearly show a resonance at E_α = 9.57 Mev, corresponding to a state at 12.39 Mev in ^{20}Ne; and there is some evidence for a weaker resonance at E_α = 9.25 Mev, corresponding to E_x = 12.13 Mev. (auth)

34830 ANGULAR DISTRIBUTION OF TRITONS FROM THE REACTION B^{10} + n AT 14.4 Mev. V. Valković (Institute "Ruder Boskovic," Zagreb). Nucl. Phys., 54: 465-71 (June 1964).

The angular distributions of tritons from the reaction $^{10}B(n,t)^8Be$ to the ground and 2.9-Mev states were measured. Both angular distributions have two pronounced maxima, one at small angles and the other at about 80°. This indicates that the reaction proceeds via the direct interaction mechanism. The Butler theory fits the first maximum in the ground-state angular distribution quite well. The deformation of ^8Be and ^{10}B nuclei makes the analysis more difficult, since higher values for the total angular momentum of the transferred deuteron are allowed. There is no possibility of distinguishing between the pickup (n,t) and the sequential pickup (n-d-t). The plane-wave theory does not give a satisfactory explanation of the angular distribution of tritons from the reaction $^{10}B(n,t)^8Be$ to the 2.9-Mev level. (auth)

34831 PARTICLE-HOLE DESCRIPTION OF THE ODD PARITY STATES OF CALCIUM 40. Vincent Gillet (Centre d'Etudes Nucleaires, Saclay, France) and E. A. Sanderson. Nucl. Phys., 54: 472-91(June 1964).

The odd parity states of ^{40}Ca were calculated in two approximations of the particle-hole model (diagonalization of the effective two-body force in the subspace of 1 $\hbar\omega$ configurations or treatment of the effective two-body force in the framework of the random-phase approximation). Isobaric spin was not assumed to be a good quantum number, and a study of the 3.76-Mev(3^-) and 4.46-Mev(5^-) levels showed the importance of Coulomb effects in describing these states. The force obtained through a partial least-squares search was somewhat more strongly attractive than usual, indicating a phenomenological renormalization of the parameters. The low-lying collective 3^- and 5^- states were correctly obtained only when using the random phase approximation. A 5^-, T ≈ 1, state at 8 Mev is indicated. The shape of the giant-dipole state is very sensitive to the details of the treatment, and the position of its main peak is a direct function of the not too well identified $1d_{\frac{5}{2}}$ hole energy. (auth)

34832 THE REACTION OF $Ne^{22}(d,n)Na^{23}$. E. B. Paul (Univ. of Manchester, Eng.) and J. H. Montague. Nucl. Phys. 54: 497-504(June 1964).

The relative yields and angular distributions of neutron groups from $^{22}Ne(d,n)^{23}Na$ were measured. The results give strong support to a spin and parity assignment of $\frac{1}{2}^+$ for the 2.39-Mev level in ^{23}Na and suggest $\frac{3}{2}^+$ of $\frac{5}{2}^+$ for the 2.98-Mev level. (auth)

34833 STRUCTURE AND ENERGY LEVELS OF LIGHT NUCLEI. H. S. Green (Univ. of Adelaide). Nucl. Phys., 54: 505-18(June 1964).

A model for light nuclei was constructed by fitting a harmonic oscillator potential to a gaussian potential to represent the N-N interaction. The Shrödinger equation of the n-body system was solved exactly to determine the energy levels, pair distributions and momentum distributions of the nucleons in the bound states of light nuclei. A satisfactory representation of the energy levels and structure of all nuclei up to ^{10}C was obtained. (auth)

34834 THE NUCLEAR REACTION $Y^{89}(d,p)Y^{90}$. Charles Watson, C. Fred Moore, and Raymond K. Sheline (Florida State Univ., Tallahassee). Nucl. Phys., 54: 519-28(June 1964).

The reaction $^{89}Y(d,p)^{90}Y$ was studied with 12 Mev deuterons. The observed Q value for the reaction is 4635 ± 5 kev. Magnetic analysis of the resulting proton groups at 45, 65, 75, 95, 105, 124, and 132.5° indicates the existence of the configurations $(p_{\frac{1}{2}})^1(d_{\frac{5}{2}})^1$, $(p_{\frac{1}{2}})^1(s_{\frac{1}{2}})^1$, $(p_{\frac{3}{2}})^1(d_{\frac{5}{2}})^1$, and $(p_{\frac{1}{2}})^1(g_{\frac{9}{2}})^1$. There is approximate agreement between the intensities of the proton groups and the statistical weights (2J + 1) for individual states within a configuration at the middle angles. Position and splittings of the resulting doublets agree well with Kim's calculations using tensor forces. There is a clear indication that the excited proton configuration $(g_{\frac{9}{2}})^1(d_{\frac{5}{2}})^1$ is populated at this bombarding energy to less than one part in a thousand relative to the ground state configuration or the excited neutron configurations. Angular distributions of the configuration using solid state detectors agree well with theory in the case of the $(p_{\frac{1}{2}})^1(s_{\frac{1}{2}})^1$ configuration, but not as well in the case of the ground state configuration. Previous work on the neutron capture gamma rays is successfully correlated with the levels observed in this work and suggests the tentative assignment of the 1^+, $(g_{\frac{9}{2}})^1(g_{\frac{9}{2}})^1$ state. (auth)

34835 THE DISTORTED-WAVES THEORY OF DIRECT NUCLEAR REACTIONS WITH SPIN-ORBIT EFFECTS. G. R. Satchler (Oak Ridge National Lab., Tenn.). Nucl. Phys., 55: 1-33(June 1964).

A general and flexible formulation is given of the distorted-waves theory of direct nuclear reactions which takes account of the effects of including spin-orbit coupling in the distortion, and which does not make the zero-range approximation. The evaluation of the transition amplitude is shown

to involve two distinct steps, one the construction of a form factor which characterizes the particular reaction mode and the particular nuclei, and the other the treatment of the dynamics of the distorted waves, which is similar for all reactions. Expressions are given for various differential cross sections and polarizations. As examples, procedures for treating inelastic scattering and stripping and knock-on reactions are described. The symmetry properties of the reaction amplitudes are also discussed. (auth)

34836 A SEARCH FOR INTERFERENCE EFFECTS BETWEEN NUCLEAR RESONANCE AND COULOMB EXCITATION IN THE $Na^{23}(p,p')$ REACTION. J. L. C. Ford, Jr., J. K. Bair, R. L. Robinson, and H. B. Willard (Oak Ridge National Lab., Tenn.). Nucl. Phys., 55: 43-8 (June 1964).

The narrow, isolated resonance in the $^{23}Na(p,p')$ reaction at 873 kev, situated upon a continuum due to coulomb excitation, would appear to be a favorable case for observing interference effects between compound nucleus inelastic scattering and coulomb excitation. The yield of 439-kev gamma radiation emitted from the first-excited state of ^{23}Na was measured from 828 to 1100 kev incident proton bombarding energy. To within the accuracy of the experimental data, about ± 8%, the non-interfering compound nucleus and coulomb excitation contributions adequately account for the resonance shape, although the presence of an interference effect cannot be definitely excluded. (auth)

34837 INTERNAL BREMSSTRAHLUNG FROM P^{32}, Sr^{89}, Y^{90}, Y^{91}, AND Bi^{210}. Boerje Persson (Univ. of Lund, Sweden). Nucl. Phys., 55: 49-78 (June 1964).

Spectra of internal bremsstrahlung from the beta decays of ^{32}P, ^{89}Sr, ^{90}Y, ^{91}Y, and ^{210}Bi were measured in a coincidence experiment. The beta particles are detected by an anthracene scintillation spectrometer and the bremsstrahlung spectrum is measured by a sodium iodide scintillation spectrometer. The isotope ^{32}P is an allowed beta emitter, and the experimental results are compared with the theory of Knipp and Uhlenbeck and of Bloch, (corrected for the coulomb effect). The agreement is very good. The isotopes ^{89}Sr, ^{90}Y, and ^{91}Y are classified as beta emitters of first order unique forbidden type. The calculations of Madansky et al., (corrected for coulomb effects) are used for comparison with the experiment. Reasonable agreement is found at the low energy ends of the spectra; but the experiment shows a considerable excess in the medium and high energy ranges. The results for ^{210}Bi are compared with the calculations of Knipp and Uhlenbeck for an allowed transition. The experimental β-spectrum was used and the coulomb correction was performed according to the method of Nilsson. It is found that the calculated spectra fit the experimental ones fairly well. (auth)

34838 THE EFFECT OF THE TENSOR FORCE ON THE ENERGY SPECTRA OF N^{14} AND F^{18} USING REALISTIC INTERACTIONS. W. J. S. Y. Young (Univ. of Birmingham, Eng.). Nucl. Phys., 55: 84-96 (June 1964).

A shell-model calculation was done to determine the effect of the tensor force on the energy levels of ^{14}N and ^{18}F. The interaction potential used was determined by the deuteron and low-energy scattering data and contained both central and tensor forces of Yukawa shapes in variable proportions. In both cases, it was found that the tensor force has a large effect on the energy levels. Although the results for the T = 1 states are in good agreement with experiment, the T = 0 states which are dependent on the tensor force are rather poor. The large discrepancies between the latter results and the observed ones were attributed to the lack of contribution to the energy matrices of the tensor force in the relative s-states in first order. The major effect of this zero contribution is to shift the ground-state level away from the experimental one. The energy differences between the various levels and the ground-state level showed that there may be an optimum central-tensor force mixture containing an appreciable tensor component which gives the observed level differences. The effect of higher order contributions from the tensor force were examined for the case of the mass 14 system by diagonalizing t-matrices which were obtained elsewhere. The level scheme obtained with these t-matrices was in reasonable agreement with experiment. The result indicates that a low-energy scattering potential would probably give the right results provided that the higher order contributions of the tensor force are properly taken into account. (auth)

34839 THE NUCLEAR ENERGY GAP AND FLUCTUATIONS IN PARTICLE NUMBER IN PAIRING WAVE FUNCTIONS. Sven Goesta Nilsson (Lund Inst. of Tech., Sweden). Nucl. Phys., 55: 97-112 (June 1964).

The effect of fluctuations in particle number for ensemble mean values calculated on the basis of BCS wave functions is investigated, in particular with reference to so-called blocked wave functions. Two simple models, the degenerate model and the homogeneous model, are studied in some detail. It is found that calculated energy changes ascribed to blocking are often largely spurious and due to a decrease in the width of the particle number distribution over the nuclear ensemble for the blocked broken-pair states relative to the ground state. A method to correct for the effect mentioned is suggested. (auth)

34840 GAMMA SPECTROSCOPY IN THE DECAY $Mn^{56} \rightarrow Fe^{56}$. J. K. Bienlein and H. Dinter (Universität, Erlangen, Ger.). Nucl. Phys., 55: 113-26 (June 1964). (In German)

The γ spectrum following the decay $^{56}Mn \rightarrow ^{56}Fe$ was measured with a 22.8 × 10.2 cm and a 6.4 × 5.1 cm NaI(Tl)-scintillation spectrometer. The half life of the β decay $^{56}Mn \rightarrow ^{56}Fe$ was found to be $T_{\frac{1}{2}} = 2.55 \pm 0.05$ h. An attempt was made to find a 4^+ level in ^{56}Fe which is populated by $^{56}Co(4^+)$, but not by $^{56}Mn(3^+)$. For the possible β-transition $^{56}Mn(3^+) \rightarrow ^{56}Fe(4^+)$ the limit log ft > 10 was found. The method of sum-coincidence spectroscopy was extended to the measurement β- and γ-branching ratios. The γ-ray intensity ratios in ^{56}Fe and the β-ray intensity ratios of the transition $^{56}Mn \rightarrow ^{56}Fe$ are given. (auth)

34841 ALPHA PARTICLES FROM THE INTERACTION OF 14-Mev NEUTRONS WITH CALCIUM. O. N. Koul (Government Engineering Coll., Jabalpur, India). Nucl. Phys., 55: 127-9 (June 1964).

Energy and angular distribution of alpha particles emitted as a result of 14-Mev neutron interaction with calcium was undertaken by the emulsion technique making use of 200 μm Ilford C_2 nuclear emulsions. The energy distribution seems to be completely Maxwellian with a peak value ranging from 4.5 Mev alpha energy with an excessive emission of alpha particles on the low-energy side. The angular distribution in the cm system is anisotropic, but approximately symmetrical about 90°. A semilog plot of relative level densities of the residual nuclei calculated from the alpha energy fits a straight line except on the low-energy side, where it becomes concave upwards. (auth)

34842 5.63- AND 5.80-Mev LEVELS OF Ne^{20}; DE-EXCITATION BRANCHING. E. Almqvist and J. A. Kuehner (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys., 55: 145-54 (June 1964).

The ratio Γ_γ/Γ for the 5.63 and 5.80-Mev levels of ^{20}Ne was determined to be 0.077 (± 0.008) and $< 3 \times 10^{-4}$, respectively, by using the $^{12}C(^{12}C,\alpha)^{20}Ne$ reaction and determining the fraction of the events in which the alpha-particle and the ^{20}Ne recoil are present in coincidence at the kinematically correct angles. In both cases these results in themselves are shown to imply radiative E1 transition (5.63 → 1.63 and 5.80 → 0, respectively) probabilities $\ll 5 \times 10^{-5}$ Weisskopf units. When taken together with the lifetime for the 5.63-Mev level measured by Evans et al., values of $\Gamma(E1) \gtrsim 5 \times 10^{-6}$ and $\Gamma_\alpha \approx 6\%$ of the single-particle estimate are obtained for this state. (auth)

34843 RADIOACTIVE DECAY OF Lu^{178}. H. Bakhru and S. K. Mukherjee (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys., 55: 161-70(June 1964).

The decay of ^{178}Lu is studied after bombarding Ta with 14-Mev neutrons, separating the Lu fraction by means of radiochemistry and using standard scintillation counter techniques. A quick method for radiochemical separation of Lu was worked out. The beta and gamma measurements show four gamma rays of energies 90, 215, 325, and 430 kev, each decaying with half lives of 30 ± 1 and 5 ± 1 min and three beta groups of maximum energies 2.25 ± 0.05 Mev (88%), 0.770 ± 0.06 Mev (12%), and 1.50 ± 0.05 Mev (98%); the first two groups decaying with a half life of 5 ± 1 min and the last one with a half life of 30 ± 1 min. A metastable state of ^{178m}Lu decaying with a half life of 30 ± 1 min is suggested; the ground state ^{178}Lu is found to decay with a half life of 5 ± 1 min. A conversion electron peak of 340-kev energy and a 60-kev gamma ray, later identified as the K x ray of ^{178m}Lu are found to decay with a half life of 30 ± 1 min only. Coincidence studies show that the gamma rays are in cascade and that none of the three beta groups is in coincidence with any of those above four gamma rays. Only the 0.770-Mev beta group is found to be in coincidence with the 332-kev gamma rays. A decay scheme based on the above observations is proposed and the results are discussed in the light of the unified model. (auth)

34844 THE K-FORBIDDEN BETA DECAY OF Tb^{160}. P. G. Hansen, N. R. Johnson, and H. L. Nielsen (Research Establishment, Risø, Denmark). Nucl. Phys., 55: 171-6 (June 1964).

The β decay of the odd nucleus ^{160}Tb ($I^\pi = 3^-$) is shown to populate the 2^+ and 4^+ states of the ground-state band of ^{160}Dy in intensities of 0.34% and 0.12%, respectively. The ratio of the reduced transition probabilities and the absolute transition strength are both compared with theoretical estimates. (auth)

34845 MEASUREMENT OF THE LIFETIME OF THE 37-kev LEVEL OF Br-80. W. Flauger and H. Schneider (Justus Liebig-Universität, Giessen, Ger.). Nucl. Phys., 55: 207-11(June 1964). (In German)

The lifetime of the 37-kev level of ^{80}Br was measured with a time-to-pulse-height converter. The results is $T_{1/2} = 7.37 \pm 0.21$ nsec. The lifetimes of the 620-kev level of ^{80}Kr and of some levels of ^{82}Kr were estimated. (auth)

34846 MICROSCOPIC MODEL OF VIBRATION-ROTATION INTERACTION IN DEFORMED NUCLEI. I. M. Pavlichenkov (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Phys., 55: 225-48(June 1964).

A hamiltonian of β and γ vibration-rotation interaction for strongly deformed nuclei is obtained on the basis of the microscopic vibrational model and rotational cranking model. With the aid of the hamiltonian thus obtained, calculations are made of the ratio of the reduced probabilities for transitions from the vibrational band to the ground-state band, of the contribution from vibrations to the term $-I^2(I+1)^2B$ in the ground rotational band, and of the difference of the moments of inertia of the β and γ vibrational bands and the ground state. (auth)

34847 RELATIVISTIC ATOMIC PHOTOEFFECT. V. G. Gorshkov, A. I. Mikhailov, and V. S. Polikanov (Inst. of Physics and Tech., Leningrad). Nucl. Phys., 55: 273-92(June 1964).

An angular photoeffect distribution with a relative accuracy of the order αZ for all angles is obtained. A term of the order $(\alpha Z)^2$ is taken into account approximately in the central part of the angular distribution. The results are compared with experiment. (auth)

34848 DIFFRACTION MECHANISM FOR ELASTIC SCATTERING AND DIRECT NUCLEAR REACTIONS. A. Dar (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., 55: 305-21(June 1964).

A phenomenological model is presented which is suitable for the description of direct nuclear reactions with unbound particles strongly interacting with complex nuclei. Expressions in closed form are given for elastic and reaction scattering amplitudes. Good agreement with experiment is found. (auth)

34849 ANGULAR CORRELATION MEASUREMENTS IN Ne^{21}. D. Pelte, B. Pvoh, and W. Scholz (Universität, Freiburg i. B.). Nucl. Phys., 55: 322-30(June 1964).

The 1.75-, 2.80-, 2.87-, and 3.67-Mev states in ^{21}Ne were studied using the $^{19}F(^3He,p\gamma)^{21}Ne$ reaction at ^{3}He energies of 4.70 and 5.20 Mev. Angular correlations between protons and gamma rays were measured with the proton counter at 0°. The spin assignment for the 1.75-Mev second-excited state was found to be $J = 7/2$. A weak direct branch of about 6% from the 1.75-Mev state to the $J^\pi = 3/2^+$ ground state and the measured quadrupole to dipole amplitude ratio $\delta = 0.11 \pm 0.04$ for the gamma transition to the $J^\pi = 5/2^+$ first-excited state imply a positive parity for the 1.75-Mev state. The $J^\pi = 1/2^+$ excited state at 2.80 Mev decays with a branching ratio of 50 : 50 to the ground state and first-excited state, respectively. From the 2.87-Mev excited state there exists a strong 1.12-Mev transition to the $J^\pi = 7/2^+$ state at 1.75 Mev accounting for more than 50% of the total decay. The decay of the 3.67-Mev excited state via a 0.87-Mev transition to the $J^\pi = 1/2^+$ state at 2.80 Mev accounts for more than 20% of the total decay. The angular correlation of the 0.87-Mev transition limits the possible spin assignments for the 3.67-Mev state to $J = 1/2$ and $J = 3/2$. It is suggested, that the 3.67-Mev state belongs to the first-excited $K = 1/2^+$ rotational band and has the assignment $J^\pi = 3/2^+$. (auth)

34850 THE DECAY OF 23.5 MIN U^{239}. K. J. Blinowska, P. G. Hansen, H. L. Nielsen, O. Schult, and K. Wien (Research Establishment, Riso, Denmark and Technische Hochschule, Munich). Nucl. Phys., 55: 331-6(June 1964).

The decay of ^{239}U was studied by means of a bent-crystal spectrometer, a six-gap spectrometer, a proportional-counter escape spectrometer, and coincidence techniques. Transitions of 43.531 kev (E1, 13%), 74.673 kev (E1, 66%), and 31.142 kev (M1 + E2, ≈16%) were observed. The beta spectrum is shown to be complex with (80 ± 4)% to the 74.7-kev level and (20 ± 4)% to the ground state. (auth)

34851 ABSORPTION OF π^- MESONS AND THE CORRELATION OF NUCLEONS IN LIGHT NUCLEI. R. I. Jibuti and T. I. Kopaleishvili (Tbilisi State Univ., Georgian, USSR). Nucl. Phys., 55: 337-49(June 1964).

The absorption of stopped π^- mesons by light nuclei with the emission of two nucleons (detected by coincidence) is

investigated in terms of the direct absorption of a meson by correlated pairs of nucleons. A study is made of the effect of the Pauli principle and interaction between the emitted nucleons in the final state, and pairing correlation of nucleons in a nucleus on the distribution of the emitted nucleons over their relative energies. The question of how the shell or cluster structure of a nucleus may show up in this distribution function is also discussed. The comparison of the theoretical value of the probability ratio $dW(\pi^- + np \rightarrow nn)/dW(\pi^- + pp \rightarrow np)$ with its experimental value for the ^{12}C nucleus warrants the conclusion that the proton-proton correlation in a nucleus must be weaker than the neutron-proton correlation. (auth)

34852 NUCLEAR RESONANCE FLUORESCENCE FROM LIGHT AND MEDIUMWEIGHT NUCLEI. E. C. Booth (Boston Univ.), B. Chasan, and K. A. Wright. Nucl. Phys., 57: 403-20(Aug. 1964).

Twenty-one nuclei with $7 < A < 65$ were examined for resonance fluorescence under bremsstrahlung bombardment in the energy region from 0.5 to 3.0 Mev. New cases of fluorescence were found, old cases were reexamined; and limits were set on cases in which no fluorescence was observed. (auth)

34853 THEORY OF POLARIZATION PHENOMENA IN DIRECT NUCLEAR REACTIONS. R. A. Abdel-Latif and G. L. Vysotskii (U.A.R. Atomic Energy Establishment, Cairo). Nucl. Phys., 57: 421-34(Aug. 1964).

Polarization phenomena in low-energy deuteron stripping reactions in the vicinity of a resonance in deuteron elastic scattering were investigated. It was assumed that the proton width of this resonance is small, therefore, the contribution of compound processes in the reaction channel was neglected. A number of relations connecting quantities observed in polarization experiments was obtained. In the case $l_n = 0$ (l_n being the orbital momentum of the captured neutron), the considered mechanism can be responsible for the major part of the contribution to the polarization effects in the reaction channel. This is due to the appearance of these effects in the elastic channel because of the interference between potential and resonance scattering. In the case for which the resonance is due to s-deuterons only, the cross section was found to depend on deuteron alignment. (auth)

34854 THE RADIAL DISTRIBUTION OF THE ABSORPTION POTENTIAL AT LOW ENERGIES. A. M. Lane (Atomic Energy Research Establishment, Harwell, Berks, Eng.) and A. P. Stamp. Nucl. Phys., 57: 444-50(Aug. 1964).

The effect of changes in the radial shape of the absorption potential on predictions was investigated. It was found that the major effect of the shape is to fix the relative absorption widths of single-particle states of the various partial waves. Experiments that would provide information on the radial shape are suggested. (D.C.W.)

34855 (p,α) REACTIONS TO N = 28 NUCLEI AT BOMBARDING ENERGIES BETWEEN 11 Mev AND 12.5 Mev. E. Veje, C. Droste, O. Hansen, and S. Holm (Universitet, Copenhagen). Nucl. Phys., 57: 451-65(Aug. 1964).

The energy level schemes of the N = 28 nuclei ^{51}V, ^{53}Mn, ^{55}Co, and ^{52}Cr were investigated using the (p,α) reaction at 11 to 12.5 Mev. The alpha spectra were measured with solid-state counters with energy resolutions of about 50 kev, and the excitation functions and angular distributions were measured with an energy spread of less than ±2 kev in the beam. It was concluded that compound-nucleus formation dominates in the reaction. The experimental level schemes are compared with theoretical predictions. (D.C.W.)

34856 DIRECT INTERACTION IN HEAVY ION REACTIONS. M. El-Nadi and T. H. Rihan (Atomic Energy Establishment, Cairo). Nucl. Phys., 57: 466-78(Aug. 1964).

Two-nucleon stripping and knock-out processes are considered for nuclear reactions produced by ^6Li ions. Applying the results to the reaction $^{197}Au(^6Li,\alpha)^{199}Hg$ it is shown that the experimental results favor the knock-out mechanism for incident energies of 61 and 33 Mev. (auth)

34857 LAMBDA-NUCLEAR FORCES AND STRUCTURE OF HYPERNUCLEI. H. S. Green (Univ. of Adelaide). Nucl. Phys., 57: 483-99(Aug. 1964).

With simplified potentials, the many-body problem is solved accurately with the initial object of determining the range and magnitude of the forces required to reproduce the experimental binding energies. It is found that, although only two-body forces are needed to fit the binding energies of light nuclei, three body forces between the Λ particle and nucleons must be introduced to secure agreement with the binding energies of hypernuclei. The strength and range of all the two-body forces and the three-body forces are determined. The two-body forces are found to be nearly independent of spin and attractive. The three-body forces are repulsive, except that there is an attraction between the Λ particle and two similar nucleons. The range of the two-body forces is too large to be attributed to heavy mesons. Details of the structure of hypernuclei are described. (auth)

34858 STRONG MAGNETIC DIPOLE TRANSITIONS IN LIGHT NUCLEI. A. B. Clegg (Nuclear Physics Lab., Oxford). Nucl. Phys., 57: 509-14(Aug. 1964).

The possibility is shown of detecting magnetic dipole transitions with $\Delta T = 0$ in light nuclei, even though such radiative transitions are very weak, in inelastic scattering of protons with energies greater than 100 Mev. Such transitions are shown to provide an excellent verification of the success of the impulse approximation in these inelastic scattering reactions. They enable the identification of a $T = 0$ magnetic dipole giant resonance of ^{12}C, similar to the $T = 1$ magnetic dipole giant resonance which has already been identified. (auth)

34859 NEUTRON SPECTRA FROM THE (p,n) REACTION IN MEDIUM-MASS NUCLEI USING 7-13 Mev PROTONS. C. Wong, J. D. Anderson, J. W. McClure, and B. D. Walker (Univ. of California, Livermore). Nucl. Phys., 57: 515-25(Aug. 1964). (UCRL-7587)

The neutron spectra from the (p,n) reaction on ^{51}V, ^{56}Fe, ^{59}Co, ^{65}Cu, ^{93}Nb, and ^{103}Rh were measured at 23° using 9 to 13 Mev protons. Using a shorter flight path, neutron spectra were also measured at 90° using 7 to 10 Mev protons. The neutron spectra were analyzed to yield level density information, using the Fermi gas level density expression $[1/(U-\delta)^2] \exp\{2[a(U-\delta)]^{1/2}\}$, where U is the excitation energy in the residual nucleus and δ is Cameron's pairing energy. The a values are given by $a = \frac{1}{8}A$, where A is the mass number of the residual or target nucleus. These a values agree well with those determined from inelastic neutron scattering experiments, from charge particle experiments and from level densities observed at the neutron binding energy. (auth)

34860 CROSS SECTIONS FOR THE $O^{18}(d,p_0)O^{17}$, $O^{18}(d,p_1)O^{17*}$ AND $O^{18}(d,\alpha_0)N^{14}$ REACTIONS FROM 0.8 TO 1.7 Mev. H. C. Kim, R. F. Seiler, D. F. Herring, and K. W. Jones (Ohio State Univ., Columbus). Nucl. Phys., 57: 526-30(Aug. 1964).

The absolute cross sections for the $^{16}O(d,p_0)^{17}O$, $^{16}O(d,p_1)^{17}*O$, and $^{16}O(d,\alpha_0)^{14}N$ reactions were measured from 0.8 to 1.7 Mev at laboratory angles of 51.4, 66.9, 86.7, 127.7, 142.2, and 164.3°. (auth)

34861 THE INTERFERENCE BETWEEN DIRECT AND COMPOUND MECHANISMS AND POLARIZATION PHENOMENA IN DEUTERON STRIPPING REACTIONS. H. Fahmy and G. L. Vysotskii (Atomic Energy Establishment, Cairo). Nucl. Phys., 57: 531-41(Aug. 1964).

Polarization phenomena in (d,p) reactions were investigated, taking into account the interference between direct and compound mechanisms of the reaction. If the orbital momentum of the captured neutron is zero, the polarization phenomena observed are due to the interference between direct and compound amplitudes. In the vicinity of a single resonance in the (d,p) reaction channel, a number of relations connecting the quantities observed in polarization experiments was obtained. (auth)

34862 PROTONS FROM THE $Cu^{63}(p,p')Cu^{63}$ REACTION AND THE EXCITED CORE MODEL. N. Cindro (Institute "Ruder Boskovic," Zagreb). Nucl. Phys., 57: 542-6(Aug. 1964).

The energy dependence of the relative excitations of four states in ^{63}Cu was studied by proton inelastic scattering at energies from 6 to 11 Mev. The results were compared to the excited core model of odd-mass nuclei, namely to the 2J + 1 intensity rule. While the predictions of the model generally hold for higher energies ($E_p \geq 9$ Mev), serious discrepancies arise for lower energies. It is suggested that these discrepancies are due to higher order effects not present in the DWBA treatment. (auth)

34863 INTERACTION OF FOUR LIKE NUCLEONS IN THE SAME SHELL. Walther J. Mulhall and Leopold Šips (Universitet, Copenhagen). Nucl. Phys., 57: 565-78(Aug. 1964).

A system of four like nucleons interacting via quadrupole and δ-function forces in the $j = 9/2$ or the $j = 11/2$ shell is investigated. The exact solutions are compared to those given by the aligned coupling scheme (rotational model) and to quadrupole harmonic vibrations in a j shell. Because of the limited possibilities for correlation offered by the system the agreement is not striking. However, special features of the model are observed, and deviations are discussed. (auth)

34864 SUPERFLUIDITY IN FERMI SYSTEMS ESPECIALLY IN ATOMIC NUCLEI. D. Zawischa (Österreichische Hochschule, Vienna). Nucl. Phys., 57: 579-92(Aug. 1964).

It is shown that for a system of fermions, the superfluid state can be obtained by perturbation theory without the introduction of anomalous pairings. Using Green functions, the formulas describing the system at zero temperature are derived in different approximations. A self-consistent treatment is proposed. The improvement seems essential especially for a smaller number of particles with discrete energy levels available (nuclei). The connection of the present solution with the BCS and Bogolyubov theories is established. (auth)

34865 INELASTIC NUCLEON SCATTERING ON DEFORMED NUCLEI. H. W. Barz and R. Reif (Zentralinstitut für Kernforschung, Rossendorf, Ger.). Nucl. Phys., 57: 593-602(Aug. 1964). (In German)

The inelastic scattering of high-energy nucleons at low-lying 2^+ levels in strongly deformed heavy nuclei is investigated in the phenomenological collective model using first-order, plane-wave Born approximation. Axially symmetric and non-axially symmetric deformation is treated, taking into account the coupling of the incident nucleon to the γ-vibrational nuclear degrees of freedom. If a γ-stable potential is assumed in the nuclear hamiltonian, the quadratic term in the expansion of the deformed interaction potential in powers of the deformation parameters leads in the angular distribution to deviations from the normal Blair phase rule. The phase relation between the elastic and inelastic angular distribution depends on the nature of the excited state and the equilibrium parameter of non-axiality. It is nearly independent of the "softness" of the nucleus against γ-deformation. With a γ-unstable potential the inelastic angular, distribution to the first or second 2^+ level follows the normal and the anomalous Blair phase rule, respectively. (auth)

34866 NEUTRON-NUCLEUS OPTICAL MODEL PARAMETER EFFECTS ON s-WAVE TRANSMISSION COEFFICIENTS. E. H. Auerbach and C. E. Porter (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys., 57: 603-10(Aug. 1964). (BNL-7590)

Numerical calculations of the s-wave transmission coefficients at a neutron energy of 1 kev for a nuclear optical model are presented in order to display the effects of model parameter variation. Particular attention is given to the effects of the surface diffuseness distance and of the strength of the imaginary part of the optical potential. Both volume and surface-peaked absorption are considered. The difficulties encountered in using one-dimensional models to infer three-dimensional behavior of the complex scattering length are also discussed. (auth)

34867 EXCITED STATES OF Li^6 OBSERVED THROUGH $He^4(d,d)He^4$. L. S. Senhouse, Jr. and T. A. Tombrello (California Inst. of Tech., Pasadena). Nucl. Phys., 57: 624-42(Aug. 1964).

Angular distributions ($18° \leq \theta_{cm} \leq 156°$) for the elastic scattering of deuterons from ^4He were obtained at 500 kev intervals for energies between 2.9 and 11.5 Mev. A phase shift analysis of the data was made yielding confirming evidence for the existence of d-wave, $J^\pi = 2^+$ and 1^+ levels at excitation energies of 4.9 and 6.2 Mev, respectively. Single-level analyses of the p-wave phase shifts indicate the possible presence of 2^-, 1^-, and 0^- levels at 6.8, 7.8, and 9 Mev excitation energies. The moments of the tensor polarization of the scattered deuterons were calculated and are compared to recent experimental results. The total reaction cross section is also calculated and found to be in fair agreement with experiment. (auth)

34868 ANGULAR DISTRIBUTIONS IN $C^{12} \rightarrow 3\alpha$. Ian Duck (Rice Univ., Houston, Tex.). Nucl. Phys., 57: 643-58(Aug. 1964). (TID-20388)

Feynman diagram techniques are used to calculate angular distributions of $^{12}C \rightarrow 3\alpha$ for states in ^{12}C with spin 0^+, 1^-, 2^+. The breakup is assumed to proceed sequentially through the 0^+, 2^+ states of ^8Be. The extent to which the sequential mode dominates provides a determination of the nature of the states of ^{12}C in terms of the cluster model. Pure sequential decay would indicate that these states in ^{12}C are well described as cluster model states with an alpha particle bound to a ^8Be nucleus. Angular distributions are presented for unpolarized initial states and for 2^+ states of arbitrary polarization. Application is made to states which have been studied experimentally. (auth)

34869 COUPLING SCHEMES AND EFFECTIVE INTERACTIONS IN THE NUCLEAR SHELL MODEL. S. P. Pandya (Argonne National Lab., Ill.) and I. M. Green. Nucl. Phys., 57: 658-74(Aug. 1964).

A simple form of effective nuclear interaction, is considered, which operates only in l = 0 states of relative motion of two nucleons. The consequences of such an s-state interaction model are investigated, and it is shown that important coupling schemes (such as a pairing scheme and the Elliott scheme) follow as special versions of the model. The role of the repulsive core in nuclear forces and its relation to the Elliott scheme are demonstrated. Two-nucleon and four-nucleon spectra in the 0d1s shell are calculated with such forces, and the results are compared with observed level schemes of ^{18}O, ^{18}F, ^{20}O, and ^{20}Ne. The fairly good agreement with the observed levels provides an indication of the nature of the effective interaction operative in the 0d1s shell. (auth)

34870 DOUBLET SPLITTINGS IN Y^{90} AND THE NEUTRON-PROTON RESIDUAL INTERACTION. Shigueo Watanabe (Univ. of Illinois, Urbana). Nucl. Phys., 57: 675-82(Aug. 1964).

The strength of the spin-dependent part of the central residual interaction between neutron and proton as a function of the range parameter r_0 is calculated in first-order perturbation theory from several measured doublet splittings in ^{90}Y. The strength of the spin-independent part is obtained from the binding energy of neighboring nuclei. The effect of the inclusion of the spin-orbit interaction on the doublet splitting is also discussed. (auth)

34871 INTERPRETATION OF $Pb^{206}(d,p)Pb^{207}$ REACTIONS IN TERMS OF THE UNIFIED MODEL. Ila Mukherjee and Paresh Mukherjee (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys., 57: 683-90(Aug. 1964).

An attempt was made to determine the level positions of highly excited states in ^{207}Pb and to estimate the cross-sections for exciting these levels in (d,p) reactions with ^{206}Pb in terms of the unified model. It was assumed that the neutron in the N = 126 – 184 shell is loosely coupled to the ^{206}Pb core and the interaction between the holes in the ^{206}Pb core with this extra neutron is replaced by a 2^+-phonon-neutron interaction. Good agreement is obtained for the level positions by a suitable choice of phonon energy and the phonon-particle coupling strength. But the calculated cross-sections deviate widely from the experimental values. Thus, two $1/2^+$ and two $3/2^+$ states are predicted to be strongly excited in the (d,p) reaction from the calculation, while one level for each is observed. (auth)

34872 CLUSTER MODEL OF NUCLEAR FISSION. I. ASYMMETRIC MASS DISTRIBUTIONS. H. Faissner (CERN, Geneva) and K. Wildermuth. Nucl. Phys., 58: 177-200(Sept. 1964).

The predominance of asymmetric fission for heavy nuclei and low excitation energies is explained by the lowering of the fission barrier, when energetically favored substructures are formed in the fission prone nucleus. Mass distributions are calculated under the following assumptions: an appreciable contribution comes only from states with unbroken cluster configurations, the fission probability is independent of the distribution of surplus nucleons, on both sides of the allowed mass bands defined above the fission probability decreases as a Gaussian function. The symmetry force determines the cluster configuration of the heavy fragment unambiguously to Z = 50, N = 82. Instead, the mass number of the light cluster A_1 has to vary according to mass and charge of the parent nucleus. The experimentally observed minima in the excitation energy of fragments indicate A_1 = 90, 96, and 100; A_1 = 84 has to be added on theoretical grounds. Using the contributions from the different A_1 as adjustable parameters, a good fit is obtained to the gross structure of the experimental mass distribution from the fission of ^{226}Ra to that of ^{252}Cf. A computation of unknown mass distributions is possible by interpolation. The model predicts shoulders in all mass distributions at the above mentioned mass numbers, and symmetric mass distributions for nuclei with Z > 100 and A > 264. (auth)

34873 THE INFLUENCE OF SPIN PATH MUTUAL EXCHANGE ON THE X-γ-CORRELATION BY STRIPPING REACTIONS. K. Hehl and C. Riedel (Zentralinstitut fur Kernphysik, Rossendorf, Ger.). Nucl. Phys., 58: 201-8 (Sept. 1964). (In German)

The correlation function for circularly polarized gamma rays of the (d,xγ) reaction is calculated in the distorted-wave Born approximation for the case of an optical-model potential with spin-orbit coupling. For reactions in which the nucleon is captured with l = 0, the correlation function is given by $W_0 = A(\theta_1) + \sigma B(\theta_1)\cos\theta$. Since the term $B(\theta_1)$ vanishes together with the spin-orbit interaction, this case allows the experimental investigation of the magnitude of the $1 \cdot s$ term in the optical model potential. (auth)

34874 NUCLEAR STRUCTURE CALCULATIONS FOR THE $2^-(\beta)2^+(\gamma)0^+$ DECAYS OF Rb^{86} AND Rb^{84}. S. Wahlborn. (California Inst. of Tech., Pasadena). Nucl. Phys., 58: 209-40(Sept. 1964).

Starting with the nuclear shell model, the non-relativistic nuclear matrix elements in the first-forbidden beta decays of ^{86}Rb into ^{86}Sr and ^{84}Rb into ^{84}Kr are calculated. Comparisons are made with experimental data for the $2^- \rightarrow 2^+ \rightarrow 2^0$ sequence. If a particle-surface interaction is assumed to cause the necessary admixtures, satisfactory agreement with the data is obtained. It is concluded that the 2^+ states of ^{86}Sr and ^{84}Kr cannot be understood in terms of two-particle excitations, or in terms of a purely collective picture, but show features of an intermediate description. (auth)

34875 MEASUREMENTS AND ANALYSIS OF ANGULAR DISTRIBUTION INTERFERENCE EFFECTS IN THE $Li^7(p,\gamma)Be^8$ REACTION. D. J. Schlueter, R. W. Krone, and F. W. Prosser, Jr. (Univ. of Kansas, Lawrence). Nucl. Phys., 58: 254-72(Sept. 1964).

Measurements were made which extend angular distribution information to E_p = 1700 kev in the $^7Li(p,\gamma)^8Be$ reaction. An excitation curve at 0^0 does not confirm the presence of resonances recently proposed at E_p = 720 and 870 kev. Yield curves for the gamma rays corresponding to transitions to the ground state and first-excited state are resonant at both the 441 and 1030 kev resonances. The analysis of the angular distributions show that a satisfactory fit can be made for the $a_1(E)$ coefficient in the expression $W(\theta,E) = 1 + a_1(E)P_1 + \ldots$ by assuming that the interference results from overlapping compound states of opposite parity. The best fits are obtained for four cases for which the spins and parities of the 441, 1030, 2100, and 5800 kev resonances are given, respectively, by the values $(1^+, 1^+, 1^-, 1^-)$, $(1^+, 1^+, 1^-, 2^-)$, $(1^+, 1^+, 2^-, 1^-)$, and $(1^+, 1^+, 2^-, 2^-)$. (auth)

34876 CALCULATION OF (n,α) ANGULAR DISTRIBUTIONS WITH THE AID OF A DIRECT INTERACTION PROCESS. J. N. Massot, E. El-Baz, and J. Lafoucrière (Institut de Physique Nucleaire, Lyon). Nucl. Phys., 58: 273-82(Sept. 1964). (In French)

The angular distribution in (n,α) reactions was calculated considering a competition between the processes of direct interaction (first a pick-up of ^3He and then a knock-out of an alpha particle from the target). The results are applied to $^{16}O(n,\alpha)^{13}C$ and $^{23}Na(n,\alpha)^{20}F$ reactions. (auth)

34877 LONGITUDINAL POLARIZATION MEASUREMENTS OF HIGH-ENERGY BETA RAYS WITH MOTT SCATTERING. J. Van Klinken (Rijksuniversiteit, Groningen, Netherlands). Nucl. Phys., 58: 283-8(Sept. 1964).

An arrangement for relative beta polarization measurements for energies up to 1.8 Mev is briefly described. The method of Mott scattering is used after conversion of the polarization from longitudinal to transverse by scattering in a thick high-Z deflector. The results for the degree of polarization relative to ^{90}Y are $P/P(^{90}Y) = 0.96 \pm 0.04$ at 625 kev for ^{198}Au, 1.02 ± 0.04 at 625 kev for ^{32}P and 0.95 ± 0.09 at a mean energy of 1.45 Mev for ^{148}Pm. (auth)

34878 THREE-BODY NNΛ FORCE IN RELATION TO TWO-BODY NΛ FORCE PARAMETERS IN p SHELL HYPERNUCLEI. F. Conte (Universitâ, Genoa) and S. Iwao. Nucl. Phys., 58: 299-304(Sept. 1964).

The contribution of the three-body NNΛ force from pion-exchange to the binding energy of p-shell hypernuclei is investigated. The two-body NΛ parameters calculated are in good agreement with the relevant parameters calculated by Dalitz and Downs from s-shell hypernuclei. This suggests that the three-body forces become important in the Λ binding as the mass number increases. (auth)

34879 DECAY OF Pt^{197m}. K. G. Prasad, K. P. Gopinathan, and M. C. Joshi (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., 58: 305-13(Sept. 1964).

The decay of 86-min ^{197m}Pt was investigated with scintillation coincidence spectroscopy, using a 512-channel pulse-height analyzer. The ^{197m}Pt was produced by neutron irradiation of enriched ^{196}Pt. The 346-kev isomeric transition was found to be in coincidence with a gamma ray of energy 50 ± 3 kev, establishing the presence of an intermediate level between the $13/2^+$ isomeric state and the $1/2^-$ ground state of ^{197}Pt. The K conversion coefficient of the 346-kev transition was estimated to be 4.8 ± 1.5, which agrees with an M4 multipolarity for that transition and a $5/2^-$ assignment for the intermediate level. The total conversion coefficient of the 50-kev transition shows it to be E2 in character. A beta branching to the 409-kev isomeric level in ^{197}Au was established by milking the 7s ^{197m}Au from ^{197m}Pt. The branching ratio of beta transition is estimated to be 4% from the relative intensities of the 346-kev gamma ray of ^{197m}Pt and the 279-kev gamma ray of ^{197m}Au. (auth)

34880 ANISOTROPY OF SELECTED FISSION FRAGMENTS FOR HELIUM-ION-INDUCED FISSION OF Pb^{206} AND Bi^{209}. K. F. Flynn, L. E. Glendenin, and J. R. Huizenga (Argonne National Lab., Ill.). Nucl. Phys., 58: 321-7(Sept. 1964).

Fission fragments from 42-Mev, helium-ion-induced fission of ^{206}Pb and ^{209}Bi were collected in thin aluminum catcher foils at center-of-mass angles of 90 and 165° to the beam direction. Several elements were chemically separated from the foils and purified by standard radiochemical procedures. The differential cross section ratios W(165°)/W(90°) for ^{105}Ru, ^{109}Pd, ^{112}Pd, ^{111}Ag, ^{112}Ag, ^{113}Ag, ^{91}Sr, ^{92}Sr, ^{99}Mo, and ^{83}Br were measured. The average values of W(165°)/W(90°) determined in these experiments by radiochemical techniques are 2.3 and 2.0 for ^{206}Pb and ^{209}Bi, respectively, in excellent agreement with previous results obtained with solid state counters. Since second-chance fission (α,nf) is negligible for each of these targets, the magnitude of the fission fragment anisotropy for a particular mass split is a measure of the shape of its saddle configuration. Although the saddle shapes depend on the target nucleus, the different mass splits of a particular target appear to arise from a configuration with essentially a common shape. However, the anisotropy of ^{83}Br from the fission of ^{209}Bi was 10% less than that of other fragments. This result is consistent with an increase in the effective moment of inertia of a saddle configuration containing a fragment with a 50 N shell. (auth)

34881 A KRYPTON-81 HALF-LIFE DETERMINATION USING A MASS SEPARATOR. T. A. Eastwood, F. Brown, and I. H. Crocker (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys., 58: 328-36(Sept. 1964).

The half life of ^{81}Kr was determined using a mass separator equipped with a current integrator. A natural Kr sample was irradiated with neutrons to produce ^{81}Kr. After determining the 81–82 atom ratio with a conventional mass spectrometer, the sample was processed in the mass separator, the mass-81 beam being collected in Al foil, while the mass-82 fraction was collected simultaneously in the Faraday cup of the current integrator. The number of atoms of ^{81}Kr collected in the aluminum foil was calculated from the 81–82 atom ratio and the integrated current of ^{82}Kr. The disintegration rate of the atoms was determined by counting the bromine K x rays produced in the electron-capture decay of ^{81}Kr using a NaI scintillation spectrometer, and the half life was determined. Tests using natural Kr mixed with 11-yr ^{85}Kr showed that ±3% accuracy can be achieved with the current integrator. The average of six determinations of the half life was 2.13×10^5 yr with an estimated experimental error ±5%. However, when the uncertainty in the ^{81}Kr decay energy (250 ± 90 kev) was included, the error was increased. (auth)

34882 THE DECAY OF ^{121}Te AND ^{121m}Te. R. L. Auble, W. H. Kelly, and H. H. Bolotin (Michigan State Univ., East Lansing). Nucl. Phys., 58: 337-47(Sept. 1964).

The energy levels of ^{121}Sb populated in the decay of ^{121}Te and ^{121m}Te were studied using the techniques of gamma-ray spectroscopy. Gamma transitions having energies of 38 ± 2, 68 ± 2, 103 ± 4, 470 ± 20, 510 ± 5, 575 ± 5, 910 ± 40, 1000 ± 20, and 1103 ± 7 kev were found. The following coincidences were observed: 38–470, 910, 1000, 1103; 68–470, 510; and 103–1000. A consistent decay scheme having levels at 38, 510, 575, 948, 1038, and 1141 kev is presented. A measurement of the angular correlation between the 68 and 510 kev photons yielded the result $W(\theta) = 1 + (0.066 \pm 0.009)\, P_2(\cos\theta) + (0.000 \pm 0.015)\, P_4(\cos\theta)$ which with other information, suggests spin assignments of 1/2 for the 575-kev state and 3/2 for the 510-kev state. In addition, a very weak positron branching was observed. (auth)

34883 ISOTOPIC HAFNIUM RESONANCE-ABSORPTION DATA. E. C. Hansen and M. L. Storm (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 19: 462-4(Aug. 1964). (TID-19676)

Hafnium isotopic ratio and fuel-depletion data obtained on an irradiated fuel element containing 2% natural hafnium were used to evaluate existing isotopic hafnium absorption cross sections in the resonance region. Isotopic ratios were calculated using cross sections from BNL-325 (2nd ed.) and were compared with the measurements. These solutions were inverted to obtain the ratios of the effective absorption cross sections of hafnium isotopes to the effective absorption cross section of the fuel. (D.C.W.)

34884 In^{115} THERMAL CROSS SECTION RATIOS. M. A. Greenfield (Univ. of California, Los Angeles) and R. L. Koontz. Nucl. Sci. Eng., 19: 464-5(Aug. 1964).

Self-absorption and self-scattering correction factors are discussed for measurements of the ratio of thermal activation cross sections for the 14-sec and 54-min activities of ^{116}In produced by thermal neutron capture in ^{115}In. Activity ratios measured with foils of thicknesses 26.8 and

96 mg/cm^2 are tabulated, together with the correction factors and corrected ratios. (D.C.W.)

34885 CROSS SECTION AND HALF LIFE FOR THE $Fe^{54}(n,p)Mn^{54}$ REACTION. W. H. Martin and D. M. Clare (United Kingdom Atomic Energy Authority, Warrington, Lancs, Eng.). Nucl. Sci. Eng., 19: 465-6(Aug. 1964). (TRG-Report-700)

The half life of ^{54}Mn was determined to be 303 ± 1 days by measurement of the activity decay in irradiated iron foils enriched in ^{54}Fe. Using this value and the results of irradiation of an enriched foil, together with nickel and cobalt monitors, the cross section for the ^{54}Fe(n,p)^{54}Mn reaction was determined to be 74 mb relative to 107 mb for the ^{58}Ni(n,p) reaction. (D.C.W.)

34886 RATIO OF CAPTURE-TO-FISSION IN U^{235} AT kev NEUTRON ENERGIES. L. W. Weston, G. deSaussure, and R. Gwin (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 20: 80-7(Sept. 1964).

The ratio of the neutron-capture cross section to the fission cross section (α) for ^{235}U was measured for incident neutron energies from 12 to 690 kev by a large gadolinium-loaded liquid-scintillator technique. Additional measurements at 30 and 64 kev were made by a method using a liquid scintillator and a fission chamber. The experimental values of α can be approximately described by a linear decrease from 0.374 at 10 kev to 0.177 at 210 kev, followed by a less rapid linear decrease to 0.095 at 700 kev. The results of these experiments are consistent and in reasonable agreement with other reported values of α in this energy range. (auth)

34887 ALPHA REACTION CROSS SECTIONS FOR 14-Mev NEUTRONS. A. Chatterjee (Saha Inst. of Nuclear Physics, Calcutta). Nucleonics, 22: 108-9(Aug. 1964).

A compilation of total cross sections for the (n,α) reaction on nuclei ($6 \leq A \leq 238$) at 14 Mev is presented. (C.E.S.)

34888 FAST-NEUTRON-REMOVAL CROSS SECTIONS. L. K. Zoller (George C. Marshall Space Flight Center, Huntsville, Ala.). Nucleonics, 22: 128-9(Aug. 1964).

A complete and consistent set of calculated fast neutron removal cross sections is provided for use in point-kernel and moments-method shielding calculations. The cross sections were calculated from empirical expressions that permit the determination of fast neutron effective removal cross section for any element. Cross sections are presented for 83 elements. (C.E.S.)

34889 PARTICLE-HOLE DESCRIPTION OF LEAD 208. V. Gillet (CEN, Saclay, France), A. M. Green, and E. A. Sanderson. Phys. Letters, 11: 44-6(July 1, 1964).

A nucleon-hole description of excited states in ^{208}Pb is developed in the framework of the Random Phase Approximation. Calculated states below 7.5 Mev and corresponding transition (electric) rates for gamma emission to the ground state are given. (R.E.U.)

34890 ON THE SYMMETRY PROPERTIES OF NOGAMI'S MODIFIED PAIRING HAMILTONIAN. G. Gyoergyi and J. Revai (Central Research Inst. for Physics, Budapest). Phys. Letters, 11: 47-8(July 1, 1964).

Symmetry properties of the hamiltonian according to Nogami and Lipkin, which arise as a consequence of the special choice of the constants λ_1 and λ_2 in that hamiltonian, are discussed. The many-body problem of spin-$\frac{1}{2}$ particles is considered. (R.E.U.)

34891 GROUPS OF NUCLEONS WITH PARALLEL MOMENTA AND THE NUCLEON CLUSTER REDUCED WIDTHS. L. Mailing (Moscow State Univ.), Yu. F. Smirnov, and V. G. Neudatchin. Phys. Letters, 11: 49-50 (July 1, 1964).

The reduced alpha-widths γ_α^2 are given for ^{16}O, ^{40}Ca, ^{90}Zr, ^{134}Te, and ^{208}Pb, corresponding to different states of the final nuclei (A − 4), for quasielastic high-energy knock-out of the alpha particle by, e.g., a fast proton when the final kinetic energy of the alpha particle is large enough that the penetrability factors are of no importance and the excitation spectrum of the final nucleus is defined by γ_α^2. The low-energy part of the excitation spectrum, which is caused by four holes in the outer oscillator shell, is considered. (R.E.U.)

34892 SEARCH FOR A LOW LYING $\frac{1}{2}^+$ LEVEL IN B^9. E. F. Farrow and H. J. Hay (Australian National Univ., Canberra). Phys. Letters, 11: 50-2(July 1, 1964).

The yield from the reaction ^{10}B(p,d)^{9}B was studied for E_p = 11 Mev to find a suggested 1.7-Mev level ($\frac{1}{2}^+$). Absolute conclusions cannot be drawn from the results. (R.E.U.)

34893 FLUCTUATIONS IN NUCLEAR CROSS SECTIONS. K. J. Le Couteur (Australian National Univ., Canberra). Phys. Letters, 11: 53-4(July 1, 1964).

Fluctuations in nuclear cross sections in the region of overlapping compound nuclear resonances are discussed. The density of compound nuclear states in the Fermi-gas model is determined in terms of the density g of single-nucleon states at the Fermi level, and the numerical values are determined using $a = \frac{1}{6}$ A Mev^{-1} for $a = \frac{1}{6}\pi^2 g$. (R.E.U.)

34894 THE NEUTRON TUNNELLING PROCESS IN THE COULOMB FIELD. L. J. B. Goldfarb and P. J. A. Buttle (Univ. of Manchester, Eng.). Phys. Letters, 11: 54-6(July 1, 1964).

It is shown that the two terms of the transition amplitude for the neutron tunneling process below the Coulomb barrier ($T_{fi}^{(0)}$ and $T_{fi}^{(1)}$) involving the Coulomb t-matrix representing the scattering of two cores, to which the neutron is bound, reduce to zero when combined. Therefore, the residual term of $T_{fi}^{(1)}$, which involves the matrix element of short-range interactions between Coulomb eigenfunctions, is the usual distorted-wave expression, and if the $T_{fi}^{(0)}$ term is considered dominant, it leads to a forward peak at low energies. (R.E.U.)

34895 THE g-FACTOR OF THE 248 kev STATE OF Se^{77}. W. Engels, W. Delang, U. Wehmann, and E. Bodenstedt (Universitat, Bonn.). Phys. Letters, 11: 57-8(July 1, 1964).

Sample preparation and experimental apparatus for measurement of the g-factor for the 248-kev state in ^{77}Se by spin rotation are given. The results yield g = + 0.48 ± 0.06. (R.E.U.)

34896 AN 850 μs ISOMERIC STATE IN Yb^{174}. J. Kantele (Univ. of Helsinki). Phys. Letters, 11: 59-60(July 1, 1964).

A time-of-flight delayed coincidence technique was used to measure directly the half life of the ^{174}Yb isomer at 1520 kev to obtain more information on the rare strongly K-forbidden isomeric transitions and the structure of ^{174}Yb. (R.E.U.)

34897 EXCITATIONS OF MASS 40 NUCLEI. G. F. Nash (Oxford Univ.). Phys. Letters, 11: 61-3(July 1, 1964).

Preliminary results are given of applying the unitary shell model to mass-40 nuclei. The states are classified by their supermultiplet and unitary symmetries. (R.E.U.)

34898 HFS-INTERACTION OF THE Gd^{155} NUCLEUS IN THE 87 kev EXCITED STATE. E. Bozek, A. Z. Hrynkiewicz, S. Ogaza, and J. Styczen (Inst. of Nuclear Physics, Krakow). Phys. Letters, 11: 63-5(July 1, 1964).

The hfs-interaction of the 87-kev level of ^{155}Gd with the electronic shell of Gd^{3+} was investigated using the attenuation of γ-γ angular correlation in a magnetic field of 1500 gauss. The hyperfine structure constants were calculated, and the g-factor for the 87-kev state was found to be ~0.28. This article appeared previously in NSA (18: 21211). (R.E.U.)

34899 DELAYED PROTON EMISSION FOLLOWING THE DECAY OF Ne^{17}. R. McPherson, J. C. Hardy, and R. E. Bell (McGill Univ., Montreal). Phys. Letters, 11: 65-7(July 1, 1964).

The delayed-proton spectra from fluorine-containing targets were observed following cyclotron bombardment reactions $^{19}F(p,3n)^{17}Ne$. (R.E.U.)

34900 THE ISOTOPE SHIFT IN THE K_α μ-MESIC X-RAYS OF Ca^{40} AND Ca^{44}. R. C. Cohen, S. Devons, A. D. Kanaris, and C. Nissim-Sabat (Columbia Univ., New York). Phys. Letters, 11: 70-2(July 1, 1964).

The isotopic shift in energies of 2p–1s transitions in $^{40,44}Ca$ was measured using a simultaneous-measurement technique. The isotope difference in charge radius is discussed. (R.E.U.)

34901 THE REACTION $Si^{28}(\gamma,p)Al^{27}$. K. H. Lokan, G. R. Hogg, P. H. Cannington, and R. J. J. Stewart (Univ. of Melbourne). Phys. Letters, 11: 73-4(July 1, 1964).

The photoproton spectra observed from ^{28}Si under bremsstrahlung bombardment of maximum energy 21.2 Mev is given. A silicon surface barrier detector was used. The relative cross sections are given. (R.E.U.)

34902 ELASTIC SCATTERING OF 24.7 Mev ALPHA PARTICLES. A. Budzanowski, K. Grotowski, S. Micek, H. Niewodniczanski, J. Sliz, A. Strzalkowski, and H. Wojciechowski (Inst. of Nuclear Physics, Krakow). Phys. Letters, 11: 74-6(July 1, 1964).

The elastic and Rutherford cross sections are compared for 24.7-Mev alpha scattering from O, Mg, Al, Si, Ca, Mn, Co, Ni, Cu, Ge, Zr, Ag, In, Sn, Hf, W, Au, Bi, and U. (R.E.U.)

34903 CALCULATION OF THE HYPERFINE SPLITTINGS OF THE ^1D LEVELS OF He^3. N. Bessis, H. Lefebvre-Brion, and C. M. Moser (Centre de Mécanique Ondulatoire Appliquée, Paris). Phys. Rev., 135: A957-9 (Aug. 17, 1964).

The ^3He hyperfine splittings of the ^1D levels are shown to arise from the admixture of ^3D states through the total spin-orbit interaction and the magnetic interaction between the nucleus and the 1s electron (Fermi contact term). The results of the calculation using hydrogen-like functions are in qualitative agreement with the splittings observed recently by B. Decomps et al. for the 4, 5, and 6 ^1D levels (60–80 Mc). The repulsion between ^1D and ^3D levels is also sufficient to explain the specific isotope shift observed for ^1D levels of helium. (auth)

34904 MEASUREMENT OF SPECTRAL DISTRIBUTION OF POSITRON FLUX IN AN INFINITE COPPER MEDIUM CONTAINING Cu^{64}. W. H. Wilkie and R. D. Birkhoff (Oak Ridge National Lab., Tenn.). Phys. Rev., 135: A1133-8 (Aug. 17, 1964).

The spectral distribution of the flux of positrons inside a beta radioactive medium was experimentally determined using an anthracene coincidence scintillation spectrometer. Positrons leaving a copper cavity or plane source containing ^{64}Cu were absorbed in a thin anthracene crystal. The light pulses from the anthracene were analyzed and recorded if a NaI scintillation spectrometer nearby recorded simultaneously a count under the total absorption peak for annihilation radiation. Thus anthracene pulses due to absorption of negatrons and secondary electrons were not recorded. The spectra were corrected for the nonlinear pulse-height-energy characteristic of anthracene by using a semiempirical theory of Birks. This correction was shown to change an observed nonlinear Fermi plot of ^{147}Pm to the accepted linear shape. The positron spectra were compared with the theoretical continuous slowing-down model. Over the range measured (20–650 kev) it was concluded that the continuous-slowing-down model gives the correct shape for the primary slowing-down spectrum for the cavity source, but that the plane source exhibited a deficiency of low-energy positrons. (auth)

34905 SHELL-MODEL STATES IN Ca^{49}. E. Kashy, A. Sperduto, H. A. Enge, and W. W. Buechner (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 135: B865-71(Aug. 24, 1964). (TID-20519)

The energy-level structure of ^{49}Ca was investigated by the deuteron-stripping reaction $^{48}Ca(d,p)^{49}Ca$. Ten excited levels were observed below 6.1 Mev; and the energies, angular momenta, and parities were determined for most of the levels. The analysis of the angular distributions of the reaction protons permitted the identification of single-particle configurations at the following energies: $2p_{\frac{3}{2}}$ = 0 Mev; $2p_{\frac{1}{2}}$ = 2.028 Mev; $1f_{\frac{5}{2}}$ = 3.95 Mev; $1g_{\frac{9}{2}} \geq 4.02$ Mev; and $2d_{\frac{5}{2}} > 4.4$ Mev. (auth)

34906 SHAPE INDEPENDENCE OF LOW-LYING STATES OF NUCLEI. Chindhu S. Warke and Yeshwant R. Waghmare (Univ. of California, San Diego, La Jolla). Phys. Rev., 135: B872-4(Aug. 24, 1964).

An attempt is made to show that the calculations in nuclear spectroscopy do not depend much on the radial shape of the two-body potential. Explicit calculations on ^{58}Ni and ^{206}Pb are made for Gaussian, exponential, and Yukawa potentials. It is also shown that the insensitivity to the nuclear potential shape, first pointed out by Blatt and Jackson in the case of low-energy scattering data, is useful in systematizing a variety of data. (auth)

34907 PERTURBED ROTATIONAL BAND SPECTRA OF SOME TWO-QUASIPARTICLE $K\pi = 0^-$ STATES IN DEFORMED EVEN-EVEN NUCLEI. S. M. Harris and C. J. Gallagher, Jr. (Columbia Univ., New York). Phys. Rev., 135: B875-83(Aug. 24, 1964).

In deformed nuclei two states with $K_1\pi_1 = \frac{1}{2}^-$ and $K_2\pi_2 = \frac{1}{2}^+$ can couple to form a degenerate doublet with projections 0 and 1. The effect of the Coriolis force and the spin-dependent residual interaction on such states was investigated. As a result of these interactions, the rotational bands are strongly mixed, and the level ordering becomes quite complicated. For certain $K = \frac{1}{2}$ states, the lowest lying members of the rotational band resemble the $K\pi = 0^-$ bands observed in deformed even nuclei in that the band ordering is 1, 3, 5, and the effective moment of inertia is significantly larger than that of the ground-state band. However, such bands are usually assigned as $K\pi = 0^-$ projections of $\lambda = 3$ (octupole) vibrations. Thus, the difference in appearance between the bands belonging to collective and two quasiparticle $K\pi = 0^-$ base states may in some cases be less than previously suspected, and definite assignments should require more detailed experimental data than the band ordering alone. (auth)

34908 EFFECT OF QUADRUPOLE COLLECTIVE MOTIONS ON THE GIANT DIPOLE RESONANCE. A. K. Kerman and Ho Kim Quang (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 135: B883-91(Aug. 24, 1964). (TID-20452)

The photonuclear model which includes both scalar and tensor polarizabilities is refined by considering small vibrations of the nuclear shape deformation. The effects of these zero-point vibrations on the structure of the giant dipole resonance for elastic and inelastic scattering were investigated in an adiabatic approximation. (auth)

34909 DIFFERENTIAL CROSS SECTIONS FOR THE REACTION $B^{11}(d,p)B^{12}$ FOR E_D = 1-2.6 Mev. Richard M. Tisinger, Jr., P. W. Keaton, and George E. Owen (Johns Hopkins Univ., Baltimore). Phys. Rev., 135: B892-4 (Aug. 24, 1964).

The angular distributions of the protons from the nuclear reaction $^{11}B(d,p)^{12}B$ leading to the ground state of the residual nucleus were measured at bombarding energies of 1.0, 1.5, 2.0, and 2.6 Mev. Self-supporting boron films were used as targets, and the outgoing particles were detected with surface-barrier solid-state detectors. Protons from the reaction $^{16}O(d,p)^{17}O$ leading to the first excited state of ^{17}O are practically indistinguishable from the protons under investigation and were subtracted from the data during the analysis. The resulting absolute differential cross sections were fitted using the deuteron–heavy-particle stripping theory. (auth)

34910 CALCULATIONS OF INELASTIC SCATTERING OF NEUTRONS BY HEAVY NUCLEI. E. H. Auerbach and S. O. Moore (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 135: B895-911(Aug. 24, 1964). (BNL-7962)

Neutron-scattering cross-section data between 0.1 and 3.0 Mev for U, Th, Bi, Pb, Au, W, and Ta were fitted using a local, spherical, spin-dependent optical potential with a minimum number of parameters. Total cross sections and differential elastic angular distributions, corrected to include compound elastic scattering, are used. With the "entrance-channel" parameters thus determined, the Hauser-Feshbach statistical model gives reasonable predictions of the cross sections for inelastic scattering of neutrons by ^{238}U, ^{232}Th, ^{209}Bi, ^{208}Pb, ^{197}Au, ^{184}W, and ^{181}Ta. The latitude in fitting entrance-channel data allowed by the optical-model parameters is sufficient to mask effects arising from nonlocality, deformation, and width distributions. To a very high degree, this relatively simple model is adequate for the presently available data. (auth)

34911 SCATTERING OF PIONS BY LIGHT NUCLEI. Morton M. Sternheim (Yale Univ., New Haven). Phys. Rev., 135: B912-20(Aug. 24, 1964).

The scattering of pions by light nuclei is calculated using an approximate, high-energy, small-angle multiple-scattering expansion which neglects off-the-energy-shell scattering. The approximations needed to obtain this expansion from an exact multiple-scattering theory are examined. It is found that the unknown contribution of the off-the-energy-shell scattering makes any calculation of pion-nucleus scattering unreliable for large angles. Using π-N phase shifts and electron-scattering data, results are obtained for the scattering of pions of about 80 Mev by Li, C, and O. (auth)

34912 ELECTROMAGNETIC STRUCTURE OF THE 3-NUCLEON SYSTEM. David A. Krueger and A. Goldberg (Univ. of Washington, Seattle). Phys. Rev., 135: B934-9 (Aug. 24, 1964). (TID-20557)

The cross sections for elastic scattering of high-energy electrons on ^3He and ^3H are calculated. The nuclear ground-state wave functions are assumed to consist of a dominant fully symmetric S state with either Gaussian or exponential space dependence and a small component of D state. Effects of relativistic terms in the nuclear current and of the exchange currents are also included. The results are compared with the experimental data of Hofstadter, Collard, and Yearian. The data can be fitted to within their experimental limits for both ^3He and ^3H. The best fits are not obtained by choosing the same wave parameters for both nuclei. (auth)

34913 LOW-LYING COLLECTIVE STATES OF Sm^{152} AND Sm^{154}. Robert A. Kenefick and Raymond K. Sheline (Florida State Univ., Tallahassee). Phys. Rev., 135: B939-44(Aug. 24, 1964).

The excited states up to 2 Mev in ^{152}Sm and ^{154}Sm were studied by magnetic analysis of the inelastic protons from thin targets bombarded by a 12-Mev proton beam. The results are compared with previous studies and with the predictions of collective nuclear models. The ground-state band levels up to spin 6 are excited in these experiments. The 2+, 3+, and 4+ states in the gamma vibrational band, the 0+ and 2+ states in the beta vibrational band, and the 1−, 3−, and 5− states in the octupole band were observed in ^{152}Sm. In ^{154}Sm the gamma band head is observed at 1443 kev, and the octupole band head is observed at 927 kev. Additional levels in these bands and the beta band are suggested. Several other levels are observed above 1100 kev in these nuclei. (auth)

34914 FISSION CROSS SECTION OF Pu^{241}. M. S. Moore (Phillips Petroleum Co., Idaho Falls, Idaho), O. D. Simpson, T. Watanabe, J. E. Russell, and R. W. Hockenbury. Phys. Rev., 135: B945-52(Aug. 24, 1964).

The low-energy, neutron-induced fission cross section of ^{241}Pu was measured from 2 to 100 ev with sufficiently high resolution to permit multilevel analysis below neutron energies of 36 ev. The results of the analysis are consistent with the assumption that the resonances can be separated into two groups having different average fission widths and that the interference effects can be described by a single-fission channel for each group. The properties of resonances from 12 to 36 ev are found to be very similar to those below 12 ev, described previously. On the basis of the parameters obtained, the number of effective fission channels is discussed. (auth)

34915 MESON EFFECTS IN n-p CAPTURE. G. Stranahan (Purdue Univ., Lafayette, Inc.). Phys. Rev., 135: B953-60(Aug. 24, 1964).

A contribution to the n-p capture amplitude which results from the modification of the nucleon current operators by the nuclear interaction is calculated. The two-nucleon states are represented by Heitler-London states, and the capture amplitude is related to single-nucleon matrix elements by means of an expansion corresponding to the exchange of mesons between the nucleons. These single-nucleon matrix elements are evaluated using the fixed-source theory. The one-meson excited Heitler-London state gives a contribution similar to the isobar model of Austern; the role of this state in the nuclear potential is also discussed. If a deuteron wave function with a relatively large D-state probability is used, the interaction effect is about 3% of the phenomenological cross section. (auth)

34916 ELECTROPRODUCTION OF PROTONS AT 1 AND 4 Bev. K. W. Chen, J. R. Dunning, Jr., J. R. Rees, W. Shlaer, J. K. Walker, and Richard Wilson (Harvard

Univ., Cambridge, Mass.). Phys. Rev., 135: B1030-3 (Aug. 24, 1964).

Protons with energies of 110 to 450 Mev were produced by bombardment of ^{6}Li, C, Al, and Cu by electrons of 1- and 4-Bev energy. It is shown that the electromagnetic interaction of the virtual photons with the nucleus is consistent with an interaction with one nucleon, followed by a subsequent scattering process. This is in contrast to the interaction at lower energies (~100 Mev), where the interaction takes place by absorption from two nucleons in the nucleus simultaneously (quasideuteron model). Deuterons were also observed and are believed to be produced by a pickup process. (auth)

34917 DETAILED FORMS OF YIELD CURVES FROM SEMITHICK ALUMINUM TARGETS. J. K. Skofronick, J. A. Ferry, D. W. Palmer, G. Wendt, and R. G. Herb (Univ. of Wisconsin, Madison). Phys. Rev., 135: A1429-36(Aug. 31, 1964). (COO-7-331)

Accurate measurements were made of the detailed shapes of γ-ray yield curves from semithick aluminum targets over the 992-kev resonance. Detailed information from these targets was possible through the use of a new electronic device which allowed data to be taken while incrementing the target voltage to provide energy changes and simultaneously correcting for energy fluctuations in the beam. To provide pure targets, fast evaporation rates were used with pressures usually 3×10^{-7} torr or less. During runs the pressure was usually 3×10^{-9} torr or less. No contamination effects appeared. Experimental results were compared to curves computed by Monte Carlo techniques for an assumed collision spectrum in which the contributions of electrons from each shell were computed using the Born approximation. These calculated curves gave closer fits to the experimental data than previous curves for which all electrons were assumed to be free and stationary. The experimental results departed somewhat from those calculated because nonuniformities in target thickness were not completely eliminated. Some additional results on thick targets show that surface contamination can take place if O_2 and N_2 gases are introduced into the vacuum system. (auth)

34918 PROTON ENERGY-LOSS DISTRIBUTIONS FROM THIN CARBON FILMS. A. L. Morsell (Univ. of Wisconsin, Madison). Phys. Rev., 135: A1436-43(Aug. 31, 1964). (TID-20097)

A 992-kev proton beam, limited in energy spread by a 1-m electrostatic analyzer, passes through a thin carbon film before entering a second 1-m electrostatic analyzer. The energy distribution of protons in the second analyzer is measured by sorting proton counts from a detector at the analyzer exit according to the instantaneous value of a sweep voltage applied to one of the analyzer plates. A combined resolution of 30,000 was obtained for the double-analyzer system. Carbon films with thicknesses corresponding to mean energy losses ranging from several kev down to about 200 ev were studied. Several of the experimental energy-loss distributions are compared with distributions computed by Monte Carlo techniques for three different assumed discrete energy-loss spectra. Good fits are obtained from a new spectrum constructed using the results of some computations by E. Merzbacher. (auth)

34919 NUCLEAR MAGNETIC RESONANCE SHIFT OF Xe^{129} IN SOLID XENON. D. Brinkman (Rutgers State Univ., New Brunswick, N. J.). Phys. Rev. Letters, 13: 187-8 (Aug. 10, 1964).

The difference (shift) ΔH between the local magnetic field at a nucleus in a solid sample and the local field in a gas sample with both samples in the same external magnetic field H_0 was measured as a function of density ρ for three values of H_0. It was found that ΔH is directly proportional to H_0, and it was verified that ΔH varies linearly with ρ. The observed rate of change of ΔH with ρ was, however, about four times smaller than that previously reported. The change in ΔH at the triple point transition between liquid and solid phases was also determined. (D.C.W.)

34920 RECOILLESS GAMMA-RAY EMISSION AFTER ALPHA DECAY. J. A. Stone and W. L. Pillinger (E. I. du Pont de Nemours & Co., Aiken, S. C.). Phys. Rev. Letters, 13: 200-2(Aug. 10, 1964). (TID-20855)

Mössbauer absorption spectra of the 59.6-kev gamma of ^{237}Np were obtained using NpO_2 absorbers and sources of ^{241}Am and ^{237}U in NpO_2, following alpha decay of the ^{241}Am and beta decay of the ^{237}U. Spectra were obtained with both the source and absorber at 4.2 and 77°K. The resonance absorption observed after alpha decay is a large fraction of that observed after beta decay. (D.C.W.)

34921 NEW VALUE FOR THE FINE-STRUCTURE CONSTANT α FROM MUONIUM HYPERFINE STRUCTURE INTERVAL. W. E. Cleland, J. M. Bailey, M. Eckhause, V. W. Hughes, R. M. Mobley, R. Prepost, and J. E. Rothberg (Yale Univ., New Haven). Phys. Rev. Letters, 13: 202-5(Aug. 10, 1964).

The ground-state hyperfine structure interval of muonium in argon was measured to a higher precision than was previously obtained and was used to evaluate the fine-structure constant. The structure interval for hydrogen was calculated; a rather large divergence from the experimental value was obtained. The term accounting for proton structure and recoil in the interval expression was also evaluated. (D.C.W.)

34922 MONTE CARLO INTRANUCLEAR CASCADE CALCULATIONS ON C^{12} WITH MEDIUM-ENERGY PHOTONS. E. Gradsztajn (Institut du Radium, Orsay, France). Phys. Rev. Letters, 13: 240-1(Aug. 17, 1964).

The cross sections for the cascade reactions (p,pα), (p,3pxn), and (p,2pxn) on ^{12}C were calculated for three probabilities (0, 30, and 40%) for proton collisions with alpha clusters. The total inelastic cross section and excitation energy distributions were also obtained. The results are in good agreement with experiment. (D.C.W.)

34923 LIFETIMES OF $d_{\frac{3}{2}}$ HOLE STATES IN SCANDIUM ISOTOPES. R. E. Holland, F. J. Lynch, and K.-E. Nysten (Argonne National Lab., Ill.). Phys. Rev. Letters, 13: 241-3(Aug. 17, 1964).

The gamma rays (150 ± 3, 13 ± 1, and 760 ± 20 kev, respectively) of the first excited states of ^{43}Sc, ^{45}Sc, and ^{47}Sc were observed using the reactions ^{40}Ca(α,p)^{43}Sc, ^{43}Ca(p,n)^{43}Sc, ^{45}Sc(p,p')^{45}Sc, and ^{48}Ti(d,^{3}He)^{47}Sc. The mean lives, conversion (M2) coefficients, and partial gamma mean lives of the levels were determined. The states were verified to be metastable and explicable as $d_{\frac{3}{2}}$ hole states formed by promoting a $d_{\frac{3}{2}}$ proton to the $f_{\frac{7}{2}}$ shell. (D.C.W.)

34924 LEVELS OF ^{32}S EXCITED IN THE ^{28}Si(α,γ)^{32}S AND ^{31}P(p,γ)^{32}S REACTIONS. P. J. M. Smulders (Rijksuniversiteit, Utrecht). Physica, 30: 1197-1207(June 1964).

Alpha emitting levels of ^{32}S in the $E_x = 9-10$ Mev region were studied by means of (α,γ) and (p,γ) reactions. In the ^{28}Si(α,γ)^{32}S reaction, with alpha particles in the 2.0–3.3 Mev range, four resonances were observed at E_α = 2.618, 2.878, 2.904, and 3.162 Mev. The latter three correspond to ^{31}P(p,γ)^{32}S resonances at E_p = 618.9, 642.1, and 875.5 kev. The spins and parities of the four resonant states, as determined by angular distribution and correlation measure-

ments, are 1^-, 2^+, 1^- and 2^+, respectively. The (α,γ) and (p,γ) yields were also measured. From corresponding (α,γ) and (p,γ) resonance energies, a Q value of 1919 ± 4 kev was found for the $^{31}P(p,\alpha)^{28}Si$ reaction. (auth)

34925 ON THE n-p PHOTODISINTEGRATION OF HEAVY NUCLEI. Arne Reitan (Norges Tekniske Hogskole, Trondheim, Norway). Proc. Phys. Seminar Trondheim, No. 5, 38p.(1964).

The total cross section for direct absorption of gamma rays by neutron-proton pairs is evaluated for nuclear matter in the effective-mass approximation and for photon energies up to about 200 Mev. Some consideration is given to the influence on the cross section of the finite size of actual nuclei. Electric dipole and quadrupole as well as magnetic dipole transitions are taken into account. (auth)

34926 QUASI-DEUTERON PRODUCTION BY γ-RAYS IN THE NUCLEUS ^{16}O. Erlend Oestgaard (Norges Tekniske Hogskole, Trondheim, Norway). Proc. Phys. Seminar Trondheim, No. 6, 30p.(1964).

The total cross section for direct absorption of gamma rays by neutron-proton pairs is evaluated for oxygen on the assumption of shell-model, initial-state wave functions. Electric dipole and quadrupole and magnetic dipole transitions are taken into account. The results are compared with other theoretical and experimental results. (auth)

34927 PAIRING CORRELATIONS IN FINITE SYSTEMS. II. SIMPLIFIED WAVE FUNCTIONS AND MOMENTS OF INERTIA OF NUCLEI. B. H. Flowers, J. M. Irvine, and I. P. Johnstone (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 84: 111-23(July 1964).

Using trial wave functions previously proposed by Flowers and Irvine, approximations are derived which allow the parameters and energies of seniority 1 and 2 states to be calculated from a single variational calculation of the seniority 0 ground state. The wave functions so obtained are used in conjunction with the Inglis formula for the moment of inertia. As in the Belyaev approach, the effect of pairing is found to reduce the moment of inertia to about half the rigid-body value, but some of the ambiguities of that approach are removed. The effect of two-pair excitations was re-examined, and the results were applied to the nickel isotopes. (auth)

34928 FORM FACTORS FOR MEDIUM AND HEAVY NUCLEI. L. R. B. Elton and A. Swift (Battersea Coll. of Tech., London). Proc. Phys. Soc. (London), 84: 125-31 (July 1964).

Data on electron elastic scattering differential cross sections were analyzed and interpreted in terms of nuclear form factors. It was concluded that the surface thickness of the proton distribution is smaller than was previously believed and that there is some evidence that the proton density is depressed at the center of the nucleus for nuclides in the region A ≃ 58. The evidence from scattering by neighboring nuclei also indicates that there is little difference, if any, between the proton and neutron distributions and that the nuclear compressibility is the same in the region A ≃ 58 and in the region of heavy nuclei. (auth)

34929 A DIRECT OBSERVATION OF DIFFRACTION IN NUCLEAR RESONANT SCATTERING. P. J. Black and I. P. Duerdoth (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 84: 169-71(July 1964).

Measurement of the spectrum for scattering from a crystal of potassium ferrocyanide in an orientation for which electronic scattering was very small revealed a diffraction peak in the ^{57}Fe nuclear resonance scattering. (D.C.W.)

34930 PAIRING CORRELATIONS IN EXCITED NUCLEI WITH SPECIFIED ANGULAR MOMENTUM. Tetsuo Kammuri (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 31: 595-608(Apr. 1964).

The effect of pairing correlations on the properties of excited nuclei having definite value of the projection of the total angular momentum along the quantization axis is considered using the statistical mechanics of the BCS model of superconductivity. In the zero temperature limit fixing the angular momentum projection, the blocking effect is obtained—pair formation in the low lying states with specified angular momentum is greatly reduced as compared with the ground state. As the temperature increases, pair formation is recovered considerably. The transition energy below which the Fermi gas model is invalidated depends little on the angular momentum. Just below the transition temperature T_c the level density and its spin dependence is approximately evaluated. In this temperature range the moment of inertia along the quantization axis changes from the rigid body value quadratically in $T_c - T$. (auth)

34931 NUCLEON-NUCLEON POTENTIAL IN THE TRIPLET-EVEN STATE. Ryozo Tamagaki, Masanobu Wada, and Wataro Watari (Hokkaido Univ., Sapporo and Osaka City Univ.). Progr. Theoret. Phys. (Kyoto), 31: 623-41(Apr. 1964).

Relations between parameters of the N-N, triplet-even potentials consistent with the n-p data are investigated. The strength of a triplet-even, spin-orbit potential can not be determined without close reference to the strength of a triplet-even, quadratic, spin-orbit potential. For a strong quadratic spin-orbit potential, strong positive spin-orbit potentials are allowable. For a weak quadratic spin-orbit potential, the tail part of spin-orbit potentials should be negative; and a positive inner part is favored by the deuteron magnetic moment. Central potentials are strongly attractive inside, and tensor potentials are weaker than the OPEP. Reliable estimation of quadratic spin-orbit potentials is important for the determination of spin-orbit potentials in the triplet-even state. (auth)

34932 NEUTRINO PAIR EMISSION FROM EXCITED NUCLEI. Shiro Sakashita (Hokkaido Univ., Sapporo) and Minoru Nishida. Progr. Theoret. Phys. (Kyoto), 31: 727-9(Apr. 1964).

Neutrino emission from excited nuclei was investigated, and the energy loss rate by neutrino emission from the more important nuclei excited in astrophysical processes was evaluated. The loss rate may be comparable to other neutrino processes in the density range from 10^5 to 10^6 g/cm^3 and is independent of density. (D.C.W.)

34933 A SURVEY OF SOME PROPERTIES OF EVEN-EVEN NUCLEI. Eugene Eichler (Oak Ridge National Lab., Tenn.). Rev. Mod. Phys., 36: 809-14(July 1964).

Some experimental observations and interpretations of one-phonon, two-phonon, three-phonon, and octupole vibrational states are summarized. (D.C.W.)

34934 RELATIVISTIC EQUATIONS AND TABLES FOR ION ENERGY DETERMINATION BY THE CROSS-OVER TECHNIQUE. Rodman Smythe (Univ. of Colorado, Boulder). Rev. Sci. Instr., 35: 1197-1200(Sept. 1964). (COO-535-523)

A relativistically exact equation is derived for the scattering angle at which ions elastically scattered from one kind of nuclei have the same energy as they do when inelastically scattered from heavier nuclei. Tables are presented for protons, deuterons, and alpha particles using

the 4.433- and 9.629-Mev levels of ^{12}C. The tables include incident energies from approximately 5 to 60 Mev. (auth)

34935 THE ANGULAR DISTRIBUTION OF FAST PHOTONEUTRONS. W. D. Heiss (Universitat, Heidelberg). Z. Physik, 179: 256-63(1964). (In German)

The angular distribution for fast photoneutrons was calculated for nuclei in the region $50 < A < 200$ by assuming the direct process. The experimental dependence of the angular distribution on the neutron number can be understood by the influence of the spin-orbit coupling on the radial integrals. (auth)

34936 THE DEPENDENCE OF INNER-OUTER EXCHANGE INTERACTIONS OF THE TlF MOLECULE ON THE VIBRATION, ROTATION, AND ISOTOPY. R. von Boeckh, G. Graeff, and R. Ley (Universitat, Bonn). Z. Physik, 179: 285-313(1964). (In German)

The hyperfine structure, Stark effect, and Zeeman effect of the TlF molecule were measured with a molecular beam resonance apparatus. The apparatus uses electric four poles as deflecting fields and a homogeneous electric field parallel to a superimposed magnetic field in the transition region. Electric dipole transitions with $\Delta m_J = \pm 1$, $\Delta J = 0$ (J rotational quantum number) were measured in the following (v,J) states (v vibrational quantum number): (0,1), (1,1), (2,1), and (0,2) of the molecule $^{205}Tl^{19}F$ and (0,1) of the molecule $^{203}Tl^{19}F$. For these five states the interaction constants were determined. The magnetic (and the electric) dipole moment of the molecule, the scalar and the tensor nuclear dipole-dipole interaction, the nuclear spin-rotational interactions, the anisotropy of the diamagnetic susceptibility $\xi_\perp - \xi_{||}$, the anisotropy of the diamagnetic shielding of the external field by the electrons at the position of the nuclei $\sigma_\perp - \sigma_{||}$. From these quantities it was possible to calculate the quadrupole-moment of the electronic charge distribution. Furthermore, the dependence of the ratio of the isotopic electric dipole moments on vibrational state was measured. A new method for determining the nuclear magnetic moments is described. The method consists of a molecular beam resonance apparatus with combined magnetic and electric transition fields and was used to measure the magnetic moments of the nuclei ^{205}Tl and ^{19}F. (auth)

34937 NUCLEAR β-DECAY. [PART] I. Berthold Stech and Lothar Schuelke (Universitat, Heidelberg). Z. Physik, 179: 314-30(1964).

In order to clarify the validity of the theory of nuclear β-transition a new formulation is given. The nuclear properties are contained in form factors, arising from a decomposition of the matrix element of the V−A operator for nuclear states. The connection of these form factors with nuclear physics matrix elements is tabulated. The total transition amplitude can be written as an integral over these form factors folded with off-shell amplitudes for elastic and inelastic electron scattering on nuclei. (auth)

34938 NUCLEAR β-DECAY. [PART] II. Lothar Schuelke (Universitat, Heidelberg). Z. Physik, 179: 331-42(1964).

A general expression for the beta-decay transition amplitude is evaluated, using the decomposition of the nuclear current matrix element into beta-decay form factors as obtained previously. For the electron radial wave functions the finite nuclear size is taken into account. Formulas for the spectrum shape factor and the polarization were calculated. (auth)

34939 ON THE COLLECTIVE g-FACTOR IN DEFORMED NUCLEI. A. Faessler and W. Greiner (Universitat, Freiburg i. B.). Z. Physik, 179: 343-6(1964). (In German)

A simple formula is derived for the collective g-factor of strong deformed nuclei. The basic idea is that the deformation is different for the protons and the neutrons because of the unequal pairing forces. The connection between the deformation and the pairing forces is derived in the quasispin model. The g-factor as a function of the two deformations is calculated in the hydrodynamical model. The known inaccuracy of the hydrodynamical model is canceled because only a ratio is needed. The agreement between theory and experiment is good. (auth)

34940 ANGULAR CORRELATION BETWEEN FRAGMENTS IN THE CASE OF THEIR MULTIPLE FORMATION. P. A. Gorichev, O. V. Lozhkin, and N. A. Perfilov. Zh. Eksperim i Teor. Fiz., 46: 1897-8(May 1964). (In Russian)

The excitation function of the process involved in the multiple emission of fragments and the angular correlations between a fragment pair formed in a single disintegration event was analyzed by means of emulsion chambers. The irradiation tests were carried out in the internal beam of the synchrophasotron with 2, 3, 6, and 9-Bev protons, determining the absolute value of the cross section on the basis of the star formation in the emulsion. The disintegration cross section of Ag and Br nuclei by 2 and 3 fragments with a $Z \geq 4$ and a mean free path of ≥15 microns, plotted as a function of the incident proton energy show a marked increase at about 1 Bev, becoming saturated at higher energies. For the study of the pair formation 309 stars with 2 fragments possessing $Z \geq 4$ were chosen, together with 46 stars, in which the ^8Li fragment and a fragment with $Z \geq 4$ were observed simultaneously. The fragments were divided into slow and fast energy groups with energies of $1.5 \leq E_f < 5$ Mev/nucleon and $E_f \geq 5$ Mev/nucleon, respectively. As the result of the disintegration with 2 fragments, 3 groups could be distinguished, containing 2 slow fragments, 1 fast and 1 slow fragment, and 2 fast fragments. In the stars of the second group, all the angles between the fragments were found to be probable but those consisting of 2 slow fragments exhibited a definite angular correlation at 120 and 140°. In the stars with 2 fast fragments, a preference toward angles of <90° was noted. For groups 2 and 3, it may be assumed that the fragments are formed independently; in the case of group 1, pairs of fragments must be formed in a single event. (TTT)

34941 INELASTIC SCATTERING OF DEUTERONS BY THE EVEN ISOTOPES OF TIN. O. F. Nemets, F. Picar, and V. V. Tokarevskii (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 46: 1898-1900(May 1964). (In Russian)

The differential inelastic scattering of 13.6-Mev deuterons by ^{116}Sn, ^{118}Sn, ^{120}Sn, ^{122}Sn, and ^{124}Sn was measured at the 2^+ excitation of the first levels ($Q \approx -1$ Mev) and also at states involved in the gross structure at $Q \approx -2.5$ Mev, using a selective scintillation spectrometer for recording the deuterons. The experimental points of the angular distribution were found to agree with the theory of R. Huby and H. C. Newns. In the angular distribution of deuterons forming a gross-structure peak at $Q = -2.5$ Mev no sufficiently clear structure could be discerned. It was previously established that in the (d,p) reactions the single-particle states of ^{118}Sn and ^{120}Sn are more easily excited than the collective states. The excitation probability of the single-particle states in the case of inelastic scattering is low; at the same time, the 2^+ quadrupole levels are excited to a greater extent by an order of magnitude than by the (d,p) reaction. Indeed, the ratio of the total cross section

$\sigma_{(d,d')}(0^+ \rightarrow 2^+)/\sigma_{(d,p)}(1/2^+ \rightarrow 2^+)$ was found to be equal to 6 and 9 for ^{118}Sn and ^{120}Sn, respectively. The actual values lie probably somewhat higher. (TTT)

34942 ELASTIC SCATTERING OF DEUTERONS BY THE STRONTIUM AND TIN ISOTOPES. O. F. Nemets, F. Picar, L. I. Slyusarenko, and V. V. Tokarevskii (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 46: 1900-1(May 1964). (In Russian)

The elastic scattering of 13.6-Mev deuterons by ^{84}Sr, ^{86}Sr, ^{87}Sr, and ^{88}Sr and ^{116}Sn, ^{118}Sn, ^{120}Sn, ^{122}Sn, and ^{124}Sn was investigated in the range from 10 to 150° by means of a scintillation spectrometer; polystyrene films covered with $SrCO_3$ were used as the Sr target. In the range of 30°, the peaks corresponding to the elastic scattering by Sr were separated from those belonging to the elastic scattering by C and O. Tin foils having a thickness of 3 to 4 mg/cm^2, enriched up to 90% in the isotope under study, were used as the Sn targets. The angular distribution curve of ^{84}Sr and ^{86}Sr indicated that in the angular range beyond 25° there is a definite structure which changes only slightly from one isotope to the other. For ^{116}Sn and ^{122}Sn, the angular distribution was measured by the rotating target method. The data obtained agree well with those reported by N. Cindro and N. S. Wall for the natural Sn at 13.5 Mev. All tin isotopes exhibit a definite diffraction-type structure; the cross section values of the various isotopes agreed with each other. An increase of the deuteron energy resulted in a marked enhancement of the distinctive character of the diffraction structure, shifting toward the low-angle region. (TTT)

34943 MULTIPLE SCATTERING OF 75- TO 200-kev PROTONS IN SOLIDS. A. A. Bednyakov, V. N. Dvoretskii, I. A. Savenko, and A. F. Tulinov (Mascow State Univ.). Zh. Eksperim. i Teor. Fiz., 46: 1901-3(May 1964). (In Russian)

The previous study on the scattering of low-energy charged particles by C was extended to materials with large Z. The angular distribution of protons scattered by thin Al and Cu layers was measured by means of nuclear emulsions placed perpendicularly with respect to the axis of the beam. An electrostatic analyzer placed behind the scattering chamber allowed to determine directly the proton energy before and after the passage of the protons through the target. The thickness of the Cu layers ranged from 190 to 530 μg/cm^2, that of the Al layers used was 52, 82, and 183 μg/cm^2; the initial proton energy ranged from 193 to 93 and 184 to 75 kev, respectively. Comparison tests were made with 46 and 82 μg/cm^2 polystyrene films in order to obtain more accurate data on scattering by C at energies below 100 kev. The values resulting from calculations carried out on the basis of the Bethe-Moller theory agreed well with the experimental data at all proton energies and target thicknesses up to the multiple scattering range, at which the effective number of collisions becomes ≤15. This agreement was somewhat unexpected because the charge exchange effect was not taken into account in the calculations. (TTT)

34944 ELASTIC SCATTERING OF PROTONS BY TRITIUM AT ENERGIES BELOW THE THRESHOLD OF THE (p,n) REACTION. Yu. G. Balashko, I. Ya. Barit, L. S. Dul'kova, and A. B. Kurepin (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 46: 1903-6(May 1964). (In Russian)

Measurement of the differential elastic scattering cross section of protons by T below the 1020-kev energy level is the most direct method for studying the state of the ^{4}He nucleus. Such measurements were carried out at energies ranging from 300 to 900 kev, plotting the angular distributions in the center of mass system and comparing the results with previous data. The results were analyzed by the least squares method on a computer, using the data of N. Jarmie et al. for the angle of 120° and energies of 300 and 350 kev. The resonance behavior of the singlet s-phase was compared with the resonance formula in the single-level approximation. At a radius of $a = 3 \times 10^{-13}$ cm, it was not found possible to describe satisfactorily the energy dependence of the phase, assuming that the proton and electron widths are equal. Using the resonance parameters obtained, it was found that the cross section of the ^{3}He(n,p)T reaction for thermal neutrons is 3100 barn and the deviation of the energy dependence of the reaction from the 1/V law amounts to 15%. Thus, an excited ^{4}He level is formed by the elastic scattering of protons by T; similar conclusions were reached on the basis of the study of the ^{3}He(n,p)T and T(d,n)pT reactions. (TTT)

34945 PHOTONEUTRON SPECTRA FROM PLATINUM, BISMUTH, LEAD AND URANIUM. Yu. Ya. Glazunov, M. V. Savin, I. N. Safina, E. F. Fomushkin, and Yu. A. Khokhlov. Zh. Eksperim. i Teor. Fiz., 46: 1906-8(May 1964). (In Russian)

The photoneutron spectra from Pt, Bi, Pb, and U were measured by the time-of-flight method in a linear accelerator, bombarding the targets containing natural isotopic mixtures, with 16-Mev electrons. The neutrons were recorded by a fission chamber placed at 35 m from the target at 90° with respect to the beam. The apparatus had a resolution of 0.150 μsec. The temperature determinations of the spectra were carried out by the least squares method, including experimental data only within the 0.2 to 1.3 Mev range for Bi and Pb and 0.2 to 2 Mev range for Pt. The formula used for the determination of the evaporation spectrum and fission spectrum of U was obtained by calculation. In the photoneutron spectrum of Bi and Pb, in addition to the evaporation spectrum, 2 groups of neutrons were found in the 1.3 to 3 Mev and $E_n > 3$ Mev ranges. The deviation from the statistical distribution in the second range is probably due to the direct interaction of the γ-quanta with the neutrons from the various shells and the nucleus. The maximum observed in the 1.3 to 3 Mev range is probably due to single particle transitions of the component nucleus. (TTT)

34946 STUDY OF THE (p,pπ$^+$) REACTION ON INDIUM-115. V. N. Rybakov and N. S. Mal'tseva (Joint Inst. of Nuclear Investigations, USSR). Zh. Eksperim. i Teor. Fiz., 46: 1911-12(May 1964). (In Russian)

Spectrally pure In, kept in an Al-foil covered quartz ampoule, was used for the tests. The target was exposed to the internal proton beam of the synchrocyclotron; after a 24-hour long cooling the Cd fraction was separated by a chromatographic method. The measurements revealed the following component half lives: 6 to 8 hours, 56 ± 2 hours, 44.6 ± 1.8 days, and several years. The maximum β-energy of the 56-hour and 44-day half-life components was 1.16 ± 0.1 and 1.4 ± 0.2 Mev. Hence, the presence of ^{107}Cd, ^{115}Cd, ^{115m}Cd and possibly also ^{113m}Cd could be established in the Cd fraction. The cross section of formation and ^{115}Cd and ^{115m}Cd were determined, assuming that at proton energies of 130 and 200 Mev they are formed as a result of a(n,p) secondary neutron reaction which is independent of the proton energy. The calculations were based on an estimation of the $\sigma(^{115m}\text{Cd})/\sigma(^{115}\text{Cd})$ ratio in the (n,p) and (p,pπ$^+$) reactions. A systematic lowering of the rise of the cross section as a function of the charge of the nucleus was noted; this might be due to differences in the absorption of π$^+$

mesons by the reactions in question in the target nuclei. The experimental values were found to agree well with previous calculations. (TTT)

34947 THE TRANSITION OF NEGATIVE μ MESONS FROM PROTON TO CARBON. V. G. Zinov, A. D. Konin, and A. I. Mukhin (Joint Inst. of Nuclear Investigations, USSR). Zh. Eksperim. i Teor. Fiz., 46: 1919-20(May 1964). (In Russian)

In the case of the stoppage of negatively charged mesons in H-containing compounds, some of the mesons are captured on the mesoatomic orbits of the proton, forming a mesoproton atom. As a result of the collisions with the atoms of the surrounding material, processes involving the fast transition of mesons to be lower energy levels of the mesoproton atom take place in the condensed media; the mesons are also strongly taken up by atoms with a charge of $Z > 1$. Similar processes occur also in the case of the stoppage of the negatively charged muons in gaseous H containing admixtures of the heavier elements. The meson transfer from the proton to the heavy ion in condensed media occurs at highly excited levels; the take-up of muons exclusively at the excited level of the Z μ-mesoatom, with subsequent cascade transition of the system to the ground state under emission of a K-meso x-ray series may be used to study the mesoatomic phenomena in H-containing media. From the experimental viewpoint, this involves the comparison of the intensities of the K series from C mesoatoms formed by the stoppage of the negatively charged muons in graphite and in polyethylene. Uptake of the muon directly at lower energy levels of the C μ-atoms may result in losses of the meso x-radiation of the K series. The problem was examined by determining the x-quantum yield from the graphite and polyethylene targets. (TTT)

34948 RATIO OF THE CROSS SECTIONS FOR FORMATION OF THE ISOMER PAIR $Sc^{44,44m}$ IN REACTIONS OF DIRECT INTERACTIONS WITH HEAVY IONS. V. A. Fomichev, B. A. Gvozdev, and V. V. Bredel (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 46: 2017-22(June 1964). (In Russian)

The $^{44m}Sc/^{44}Sc$ isomer ratio in neutron stripping reactions induced by irradiating Sc with ^{16}O or ^{22}Ne ions is measured. It is of the order of unity and is independent of energy. It is shown that during many-nucleon transfers (3pn) in the $^{27}Al + ^{40}Ar \rightarrow ^{44}Sc$ and ^{44m}Sc reaction the isomer ratio becomes ~6.5, that is, larger than in reactions of complete fusion of nuclei. (auth)

34949 INVESTIGATION OF THE $\pi^- + Xe \rightarrow \pi^- + \pi^0 + Xe$ REACTION FOR 9-Gev/c PRIMARY π^--MESONS. I. M. Gramenitskii, I. A. Ivanovskaya, T. Kanarek, L. S. Okhrimenko, A. Prokesh, and L. A. Tikhonova (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 46: 2023-7(June 1964). (In Russian)

The reaction for 9 Bev/c primary π^--mesons was studied in a xenon bubble chamber. The upper limit of the cross section for production of π^0-mesons in the Coulomb field of the Xe nucleus is estimated to be 1.0 ± 0.2 mb. (auth)

34950 VIBRATION-ROTATIONAL INTERACTION IN DEFORMED NUCLEI. Yu. N. Devyatko, V. V. Lomonosov, and M. G. Urin (Inst. of Physics and Engineering, Moscow). Zh. Eksperim. i Teor. F iz., 46: 2070-7(June 1964). (In Russian)

The vibration-rotational interaction parameters in strongly deformed nuclei are calculated according to a model in which pairing and quadrupole—quadrupole interaction between nucleons is taken into account. Results of the calculations performed in the quasiclassical approximation for particles in an oscillatory potential are compared with the experimental data. (auth)

34951 ON SURFACE NUCLEON STRIPPING REACTIONS. V. M. Strutinskii. Zh. Eksperim. i Teor. Fiz., 46: 2078-84(June 1964). (In Russian)

A simple expression for the differential cross section for nucleon transfer reactions based on the boundary collision model is derived. Various angular distributions are obtained depending on the degree of classicism of the process. The experimental data on transfer reactions involving heavy ions satisfactorily agree with the boundary collision model. Application of the formulas to other surface reactions is indicated. (auth)

34952 ON THE INTERACTION CROSS SECTION AND FRACTION OF ENERGY CONSERVED BY NUCLEONS IN COLLISIONS WITH COMPLEX NUCLEI. A. M. Lebedev, S. A. Slavatinskii, and B. V. Tolkachev (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 46: 2151-5(June 1964). (In Russian)

Cross sections for inelastic interaction between nucleons and complex nuclei are calculated on basis of the optical model of the nucleus. The dependence of cross section on atomic weight of the nucleus $\sigma = \sigma_0 A^{2/3}$ satisfactorily agrees with the experimental data. The collision multiplicity for various nuclei and also the fraction of energy of the latter which is conserved by the nucleon after interaction are computed on basis of the concept of successive interactions between the nucleon and nucleons of the nucleus. The results of the calculations are compared with experimental data. (auth)

34953 NEW DATA ON THE ^{182}W EXCITED STATES. L. N. Kondrat'ev and E. F. Tret'yakov. Zh. Eksperim. i Teor. Fiz., 46: 2241-2(June 1964). (In Russian)

The conversion electron and photoelectron spectra of ^{182}W was investigated by means of a beta spectrometer. On the basis of the multipole transitions the spin and parity of the excited states were determined. The energy level diagram of ^{182}W is illustrated. (C.E.S.)

34954 THE MEAN ENERGY OF ^{142}Pr β SPECTRA. E. I. Biryukov, Yu. S. Martynov, V. T. Novikov, and N. S. Shimanskaya. Zh. Eksperim. i Teor. Fiz., 46: 2242-3 (June 1964). (In Russian)

The mean energy of the ^{142}Pr beta spectra was determined by means of calorimetric measurements. The mean energy of the integrated spectra was found to be 791 ± 16 kev, and on the basis of the hard component of the spectra it was found to be 814 ± 16 kev. (C.E.S.)

34955 SPECTRUM OF α PARTICLES IN THE ^{244}Cm SPONTANEOUS TERNARY FISSION. N. A. Perfilov, Z. I. Solov'eva, and R. A. Filov. Zh. Eksperim. i Teor. Fiz., 46: 2244-5(June 1964). (In Russian)

The energy spectra of α particles in the ^{244}Cm spontaneous ternary fission were measured by means of photographic emulsions and photographic plates. The energy spectra have a Gaussian distribution with a maximum at ~15.5 Mev. (C.E.S.)

34956 CINÉMATIQUE DES RÉACTIONS NUCLÉAIRES. (Kinematics of Nuclear Reactions). A. Michalowicz. Monographies Dunod. Paris, Dunod, 1964. 190p.

The formalism of the kinematics of two-body nuclear collisions is developed. The classical mechanical laws applicable to corpuscular collisions are summarized, both for the non-relativistic and the relativistic domain. The formulas for the calculation of the mechanical character-

istics of particles in the center-of-mass system and the laboratory system are developed for low- and high-energy collisions. A series of tables to be used as an aid in the calculations is included. (J.S.R.)

34957 ONCE-FORBIDDEN BETA-TRANSITIONS. L. N. Zyryanova. International Series of Monographs on Nuclear Energy. Division II. Nuclear Physics. Volume 7. Translation by Prasenjit Basu of "Unikal'nyye Beta-Perekhody," a publication by Izdatel'stvo Akademii Nauk SSSR, Moscow-Leningrad, 1960. New York, The Macmillan Company, 1963. 121p.

A review of the existing theoretical and experimental results on once-forbidden beta transitions of nuclei is presented. Data on the form of the beta spectra, the total probability of transitions by beta decay, and K- and L-capture for transitions up to the third order of forbiddenness are examined. The lifetimes of the beta transitions are tabulated. Tables of functions necessary for the analysis and treatment of experimental data and a bibliography of 99 references are included. (C.E.S.)

34958 NEW ALPHA-EMITTING LEVELS IN Ne^{20}. J. A. Kuehner and E. Almqvist (National Research Council of Canada, Chalk River, Ont.). 9p. (CONF-452-5)

From American Physical Society, Washington, D. C., Apr. 1964.

Measurements on the alpha particles from ^{20}Ne levels excited in the $^{12}C(^{12}C,\alpha)^{20}Ne$ reaction revealed levels at 10.57, 12.19, and 13.39 Mev, which were assigned 4+, 6+, and 7−, respectively. (D.C.W.)

34959 NUCLEAR-PAIRING FORCE HAMILTONIAN AND PROJECTED WAVE FUNCTIONS. A. Lande (Princeton Univ., N. J.). 7p. (CONF-452-8)

From American Physical Society, Washington, D. C., Apr. 1964.

The extent to which some approximations based on the BCS method describe the spectra of low-lying nuclear states was investigated, together with the extent to which they approximate the reduction or occupation factors in matrix elements of the operators encountered in beta decay, E-M transitions, and moment calculations. Low-lying states of a simple pairing hamiltonian in second quantized form were considered. (D.C.W.)

34960 LEVELS IN Sc^{42} FROM THE $Ca^{40}(He^3,p)Sc^{42}$ REACTION. R. W. Zurmuhle (Univ. of Pennsylvania, Philadelphia), C. M. Fou, and L. Wayne Swenson. 12p. (CONF-452-17)

From American Physical Society, Washington, D. C., Apr. 1964.

The $^{40}Ca(^3He,p)^{42}Sc$ reaction was investigated with 10-, 12-, and 15-Mev ^3He beams. States of ^{42}Sc were observed at 0.58, 1.43, 1.80, 2.1, 2.3, 2.65, 2.90, 3.20, and 3.50 Mev. Angular distributions of protons leading to the ground state and 0.58-, 1.43-, and 1.80-Mev states were measured and compared to the predictions of the plane wave double stripping theory of Newns. They are consistent with the previous 0^+(L = 0) assignment for the ground state and a 2^+(L = 2) assignment for the 1.43-Mev state. The angular distribution (L = 0) and magnitude of the cross section for the 0.58-Mev state indicate that it is a 1^+ state. The weakly-excited 1.80-Mev state (L = 0) is likely a 0^+ state. (auth)

34961 A MONTE CARLO CALCULATION OF NEUTRON PRODUCTION IN HEAVY ELEMENT TARGETS BY PROTONS IN THE RANGE 0.3-1 Bev. J. C. D. Milton and J. S. Fraser (National Research Council, Chalk River, Ont.). 15p. (CONF-452-23)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

Total neutron yield, spatial distribution of yield, heat production, and neutron energy spectra were studied for 0.3- to 1.0-Bev protons incident on conical or cylindrical targets. The Monte Carlo calculation is followed through generation of cascade particles and subsequent evaporation neutrons, and emission of the evaporation neutrons. (R.E.U.)

34962 FAST-NEUTRON CAPTURE AND INELASTIC-SCATTERING CROSS SECTIONS OF In^{113} AND In^{115}. [H. A. Grench and H. O. Menlove]. 16p. (CONF-250-20)

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., Aug. 1963.

The cross sections for neutron capture and inelastic scattering by ^{113}In and ^{115}In were measured at eleven neutron energies between 0.34 and 1.05 Mev. Support for an assignment of $\frac{1}{2}$ or $\frac{3}{2}^-$, rather than $\frac{5}{2}^-$, for the 0.648-Mev level of ^{115}In was obtained. (D.C.W.)

34963 MEASUREMENT OF THE $D(d,n)He^3$ NEUTRON POLARIZATION USING A LIQUID HELIUM, TIME-OF-FLIGHT, COINCIDENCE POLARIMETER. T. G. Miller (Army Missile Command, Redstone Arsenal, Ala.). 10p. (CONF-531-8)

From American Physical Society 1964 Southwestern Meeting, Tucson, Ariz., Feb. 1964.

The neutron polarization in the reaction $D(d,n)^3He$ between 1.5 and 1.9 Mev was measured at a laboratory angle of 35° using liquid helium in a special cryostat as the polarization analyzer. Energy selection was by time-of-flight techniques, and fast coincidence between the helium detector and side counters further reduced the background. The polarization varied slowly with deuteron energy, reaching a maximum magnitude of −22.3% at 1.9 Mev. (D.C.W.)

34964 NUCLEAR RADII FOR INTERACTION IN EMULSIONS. P. K. Aditya (Indian Inst. of Tech., New Delhi). 7p. (CONF-320-7)

From International Conference on Cosmic Rays, Jaipur, India, Dec. 1963.

Assuming an inelastic interaction to occur with geometrical cross section, the mean free path of high-energy particles was used to determine the nuclear dimensions. Data on fragmentation of heavy primary nuclei of cosmic radiation were used. For a nuclear radius written as $R = r_0 \times A^{\frac{1}{3}}$, the value of r_0 was found to be 1.16 f (f = 10^{-13} cm) for nuclei other than hydrogen. From the known p-p cross section, the value 0.5 f was assumed for hydrogen. The observed mean free path of alpha particles, deuterons and protons was used to find the "size" of these projectiles. The overall size was found to be 1.7, 2.0, and 0.3 f, respectively. (auth)

34965 ANGULAR DISTRIBUTION OF DE-EXCITATION GAMMA RAYS IN COULOMB EXCITATION WITH LARGE ENERGY LOSS. D. Chattarji and P. J. Brussaard (Duke Univ., Durham, N. C.). 14p. (CONF-452-25)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

The angular distribution coefficients $b_k^{E\lambda}(\xi)$ and $b_k^{M\lambda}(\xi)$ of the gamma rays emitted by nuclei excited by coulomb excitation are calculated in the limit $\xi \gg 1$ with the use of asymptotic expansions of the coulomb integrals. These coefficients are expressed as series expansions with $\xi^{-\frac{1}{2}}$ as expansion parameter; the expansion coefficients are evaluated numerically. Numerical values are presented for $5 < \xi < 140$. (auth)

34966 NEUTRON BINDING ENERGIES IN HEAVY NUCLEI. B. L. Cohen, R. Patell, A. Prakash, and E. J. Schneid (Univ. of Pittsburgh). 22p. (CONF-452-36)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

Neutron binding energies in 53 nuclei of mass 91 to 209 were determined with 15-kev accuracy by measurements of Q-values for (d,p) and (d,t) reactions. In seven cases, there are large discrepancies with previously accepted values; these are discussed in detail. There are strong indications of subshell closure at 56 neutrons in zirconium and at 64 neutrons in tin, but these indications are much weaker at 56 neutrons in molybdenum, and non-existent at 64 neutrons in cadmium. (auth)

Plasma Physics and Thermonuclear Processes

Refer also to abstract 34266.

34967 (AFCRL-63-786) DYNAMIC NON-LINEAR WAVE PROPAGATION IN IONIZED MEDIA. 11. NON-LINEAR EXCITATION OF HYDROMAGNETIC WAVES AND HYBRID RESONANCES BY TWO INTERACTING HIGH POWER PRIMARY WAVES. Research Report No. 39. K. H. B. Wilhelmsson (Chalmers Tekniska Hogskola, Goteborg. Forsknings-laboratorium for Elektronik). July 1963. 38p. (AD-436878)

It is shown that two interacting strong waves that propagate perpendicular to the direction of a static magnetic field in an ionized gas can generate, as nonlinear products, difference-frequency fields, which may be hydromagnetic waves or exhibit so-called hybrid resonances. In the investigation, it is considered an infinitely extended homogeneous medium and the effect of collisions is neglected. (auth)

34968 (AFCRL-64-18) AN EXPERIMENTAL DETERMINATION OF ANTENNA PATTERN DISTORTION DUE TO A PLASMA LAYER. Daniel J. Jacavanco and Gerald Meltz (Air Force Cambridge Research Labs., Laurence G. Hanscom Field, Bedford, Mass.). Jan. 14, 1964. 11p. (AD-436821)

Measured radiation patterns of a plasma-covered antenna are compared with an approximate leaky wave analysis due to Oliner and Tamir. The results clearly show a shift in the optics "critical angle" and the appearance of several side lobes as predicted by theory. The plasma is produced in a He–Xe admixture at 0.4 torr by a capacitively coupled 10-Mc c-w source and contained in a rectangular pyrex vessel of interior dimensions 8 in. by 4 in. by 5 in. Electron densities in excess of 5×10^{11} per cc are measured by a standard microwave interferometer by manually balancing a bridge or automatically by displaying a set of interference "fringes" after a pattern is recorded. (auth)

34969 (AFCRL-64-247) DEVELOPMENT OF A LOW-WEIGHT MEASURING APPARATUS FOR ELECTRON DENSITIES IN A PLASMA. IIB Report No. 7. K. G. Jacobs (Germany. Deutsche Bundespost. Ionosphären-Institut, Breisach). Nov. 20, 1963. Contract AF61(052)-290. 36p. (AD-434894)

Development and characteristics of an instrument which permits measurement of the electron density by impedance measurements on a plasma condenser with variable frequency are described. Characteristic frequencies where certain resonances occur in the plasma and the amplitude of those resonances are the test values of this method. The power level of the measuring frequency can be kept low and the perturbations of the surrounding plasma are negligible. (auth)

34970 (AFCRL-64-250) THE NONLINEAR INTERACTION OF AN ELECTROMAGNETIC WAVE WITH A TIME-DEPENDENT PLASMA MEDIUM. Physical Sciences Research Papers No. 8. Robert J. Papa (Air Force Cambridge Research Labs., Laurence G. Hanscom Field, Bedford, Mass.). Mar. 6, 1964. 40p. (AD-601669)

A one-dimensional, inhomogeneous model is used to describe the nonlinear interaction of a radiofrequency plane wave with a time-varying plasma medium. A monochromatic plane wave is normally incident upon an electron-density profile where the electron-density gradients are shallow compared to a wavelength. Changes in electron temperature and density are induced, which continually alter the pattern of electromagnetic energy disposition into the medium. The electron energy relaxation time is much longer than the period of the electromagnetic wave, so that the electron temperature does not follow the rapid variations in the impressed field. The inter-electron collision frequency is much larger than the frequency for energy transfer between electron gas and neutral gas. Hence, the Maxwellianization time for the establishment of electron temperature is short compared to the time for energy transfer between electron and neutral gas. A nonlinear constitutive relation is derived for the macroscopic-current density and the impressed electric vector, assuming that the wave field is almost monochromatic in the medium. The time-dependent response of the plasma medium may be found by numerically solving the energy-balance equations and the continuity equation for the electron gas. The electron temperature is expressed in the form of a difference equation where the effects of the thermal conductivity of the electron gas may be included. The spread in frequency of the electromagnetic wave field due to the time-varying electrical conductivity may be computed by employing the WKB approximation as a solution to the wave equation for a time-varying medium. (auth)

34971 (ARL-64-85) INVESTIGATION OF THE DYNAMICS OF IONIZED MEDIA (PLASMAS). Wesley E. Brittin, Willard R. Chappell, and Arthur Y. Sakakura (Physics, Engineering, Chemistry Corp., Boulder, Colo.). May 1964. Includes APPENDIX. Robert G. Kuller. Contract AF33(657)-8131. 189p.

The statistical mechanics of the electromagnetic field is treated in a fundamental way. Probability densities for the fields $\vec{E}$ and $\vec{B}$ at given points are the basic entities entering the theory. These densities satisfy an infinite set of coupled equations analogous to but quite different in structure from the usual BBKGY hierarchy for particles. When particles are included, the equations for joint field-particle probabilities are also given. Some examples of methods useful in treating equilibrium and transport phenomena in both classical and quantum plasmas are discussed. An appendix is given to provide some of the details on the mathematical aspects of the use of functionals in the study of the statistical mechanics of fields. (auth)

34972 (ARL-64-140) ON THE COLLECTIVE DESCRIPTION OF CLASSICAL PLASMAS. Technical Note No. 1. G. Kalman (Paris. Université, Orsay. Ecole Normale Supérieure. Faculté des Sciences). [1963]. Contract AF61(052)-613. 107p.

Collective coördinates are considered as a linear transformation of deviations from the unperturbed orbit. In general, they are admixtures of particle coördinates and of particle momenta. On this basis a reformulation and

generalization of the Bohm-Pines theory and a classical equivalent of Brout's method are introduced. The correspondence of the two treatments is demonstrated. The method developed is employed to establish a collective description of magnetostatic interaction. A hamiltonian describing magnetic interaction in terms of particle variables is derived. The Fourier transform of the momentum density appears as a collective coördinate. Subsequent canonical transformations lead to a collective fluid-like description, to an extended hamiltonian with coupling, and to dressed uncoupled collective variables. A new collective mode with two transverse polarizations emerges; it exhibits an unstable behavior and prevails in the case of unisotropic velocity distribution only. In general, it is coupled to the plasma oscillation mode. The dielectric description of a system with unisotropic temperature tensor is presented. (auth)

34973 (ASD-TDR-63-696) CONTROLLED THERMONUCLEAR REACTIONS FOR SPACE PROPULSION. Robert F. Cooper and Richard L. Verga (Aeronautical Systems Div., Wright-Patterson AFB, Ohio). Sept. 1963. 27p. (AD-432018; CONF-445-3)

From Aeronautical Systems Division 1963 Science and Engineering Symposium, Wright-Patterson AFB, Ohio, Sept. 1963.

A propulsion system utilizing controlled thermonuclear reactions as an energy source is shown to possess definite advantages over all other propulsion systems in the performance of those space missions requiring a high velocity increment. No valid argument exists that indicates that controlled fusion will not be achieved. In addition, analyses indicate that no insoluble engineering problems would be associated with the adaption of controlled fusion to the propulsion of a space vehicle. A number of applicable areas of technology are discussed. These areas are either being pursued at the present time or require additional intensive effort. The inherent potential of the application is such that pursuit of this energy source for propulsion cannot be ignored or delayed. (auth)

34974 (NP-14153) DAMPING OF TRANSVERSE PLASMA OSCILLATIONS AT THE ION CYCLOTRON RESONANCE. R. M. May and J. Tendys (Sydney. Univ. School of Physics). Apr. 1964. 18p. (TR-8)

The damping length for an ion cyclotron wave in the neighborhood of its resonance in an infinite homogeneous plasma is known in two limiting cases: Landau-like damping in a collisionless plasma; and collisionless damping in a zero temperature plasma. A simplified model for collisions was used to effect an investigation that includes both finite temperature and collisions. It is found that the limiting cases above are joined by a transition region in which damping depends on both effects. (auth)

34975 (NP-14194) THEORY OF PLASMA WAVE RESONANCES IN A HOT NONUNIFORM PLASMA. Technical Report No. 23. Jerald V. Parker (California Inst. of Tech., Pasadena). June 1964. Contract Nonr 220(50). 125p.

The resonant motion exhibited by a plasma column excited by an oscillating electric field transverse to the column was studied. A theory is considered that includes the effects of electron temperature and of nonuniformities in the plasma electron density. In order to have a quantitative theory, the nonuniform electron densities used are calculated numerically using a theory due to Tonks and Langmuir. The theory yields a fourth order differential equation that is integrated numerically to find the predicted resonant frequencies. The predictions are compared with experiment and show excellent agreement. It is concluded that the nonuniform electron density plays a crucial role in determining the resonant frequencies. The effect of an axial magnetic field upon the resonances was investigated. It is shown that the field causes each resonance to split into a right and left circularly polarized resonance whose frequencies depend on the field strength. These preliminary calculations were checked with experiment and they give good qualitative agreement. Possible diagnostic uses of these these results are considered. Experimental results are given in report number NP-14195. (auth)

34976 (NP-14195) EXPERIMENTAL STUDY OF PLASMA WAVE RESONANCES IN A HOT NONUNIFORM PLASMA COLUMN. Technical Report No. 22. John C. Nickel (California Inst. of Tech., Pasadena). May 1964. Contract Nonr 220(50). 138p.

The relative frequency spectrum $\omega^2/\bar{\omega}_p^2$ of plasma wave resonances in the positive column of a low pressure mercury discharge tube was shown to depend upon the parameter r_w^2/λ_D^2 where r_w is the radius of the column, λ_D^2 is the Debye length defined in terms of the average electron density, and $\bar{\omega}_p^2$ is the square of the average plasma frequency. Observations of both dipole and quadrupole resonance spectra made on several discharge tubes with r_w ranging from 0.30 to 0.87 cm are presented. For these measurements, r_w^2/λ_D^2 varies from about 10^2 to 10^5, and the best-fit electron temperatures are found to be of the order of 3 ev. The average electron densities are directly measured using a cavity perturbation technique. The results of these observations are found to be in good agreement with the theory based upon the first two moments of the correlationless Boltzmann equation in conjunction with Parker's electron density profile for a low density positive column. The results of a preliminary investigation of the effects of an axial, static magnetic field on the dipole resonance spectrum are also presented. These results indicate that in the presence of an axial magnetic field not only does the lowest resonance (approximately predicted by the cold-plasma theory) split, but the next higher order resonance also splits. For the lowest resonance, it is found that $\Delta\omega/\omega_g \approx 0.8 \pm 0.1$, while for the next higher order resonance $\Delta\omega/\omega_g \approx 0.5 \pm 0.2$, where ω_g is the cyclotron frequency. These preliminary results are in good accord with previous calculations made using the moment equation approach. (auth)

34977 (RADC-TDR-64-94) MICROWAVE PLASMA COMPONENTS STUDY. Quarterly Report No. 15. Andrejs Olte and E. K. Miller (Michigan. Univ., Ann Arbor). Mar. 1964. Contract AF30(602)-2605. 29p. (AD-436642)

The development of a first-order theory for the transmission characteristics of a magneto-plasma resonance isolator employing the TM_{11} mode in a rectangular waveguide is continued using a tensor permittivity plasma model. The results are compared with those obtained previously where an equivalent scalar permittivity was used. Effects of variation of the magnetostatic field over the plasma volume are investigated. Some previously obtained experimental data are compared with the theoretical results. Development of a hot-cathode discharge for use as a plasma package is described and some preliminary measurements on electromagnetic wave interaction with the discharge are given. (auth)

34978 (SIT-P126) EXPERIMENTAL INVESTIGATION OF CUSPED CONTAINMENT GEOMETRIES: CHALICE. Annual Report, 1963–1964. George J. Yevick (Stevens Inst. of Tech., Hoboken, N. J.). Contract AT(30-1)-2582. 166p.

The status of the Chalice cusped-containment device is summarized. The development of components, such as low-impedance high-voltage transmission lines and collector plates, electronic control systems, capacitance bank fuses, and a low-impedance solid-dielectric series-crowbar switch, is discussed. Theoretical studies of the two-body correlation functions and vertex corrections in plasma are reported. (T.F.H.)

34979 (UCRL-11077) STABILITY AND OSCILLATION ANALYSIS OF MAGNETIC MIRROR SYSTEMS WITH CONDUCTING END PLATES (thesis). Shalom Fisher (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 19, 1963. Contract W-7405-eng-48. 167p.

The stability of a fully ionized highly conducting plasma in static equilibrium confined by an axi-symmetric mirror field is investigated. The magnetic field interpenetrates with the plasma and is tied down by conducting end plates. These conducting end plates tend to stabilize the system, since any deformation in the plasma must be accompanied by an increase in magnetic field energy. In particular, the interchange instability is inhibited. The eigenvalue theory is applied to various energy principles, and necessary and sufficient conditions for stability are derived. These stability criteria are studied for specific field configurations and particle distributions. The maximum $\beta = 2P/B^2$ for which these examples are stable is defined as β_c and computed as a function of the mirror ratio and the aspect ratio $A = \bar{r}/a$, where $\bar{r}$ is the maximum radial distance to the field lines, and 2a is the distance between the end plates. It is found that β_c decreases as the mirror ratio and the aspect ratio increase. Certain geomagnetic oscillations are studied by means of a hydromagnetic model. A variational principle is used to calculate the oscillation frequency of the model; excellent agreement with the observed frequency is obtained. (auth)

34980 SURFACE EFFECTS IN A PULSED PLASMA ACCELERATOR. William J. Guman and William Truglio (Republic Aviation Corp., Farmingdale, N. Y.). AIAA (Am Inst. Aeron. Astronaut.) J., 2: 1342-3(July 1964).

The outgassing of absorbed and adsorbed gas and its effect on accelerator performance were investigated, together with electrode erosion. (D.C.W.)

34981 ELECTRON FLUCTUATIONS IN AN EQUILIBRIUM TURBULENT PLASMA. Anthony Demetriades (Philco Corporate Research Labs., Newport Beach, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 1347-9(July 1964).

The dependence of the electron density fluctuations in a heated gas on the temperature fluctuations is derived for the case of equilibrium. Numerical equality of the root-mean-square electron density fluctuation with the average electron density is shown to be very likely. Also, the average electron density is usually much higher than the electron density computed at the mean local temperature. (D.C.W.)

34982 INVESTIGATIONS ON THE COLLECTIVE BEHAVIOR OF A CLASSICAL PLASMA. W. Macke and B. Pegel (Technische Universität, Dresden). Ann. Physik (7), 13: 9-20(Mar. 1964). (In German)

From the hydrodynamic equations given previously for a two-component classical plasma, a coupled system of wave equations for the mass density of ions and electrons was obtained in the linear approximation. The eigensolutions reveal two simple wave types. A point charge moving through the plasma can excite both possible wave types in the excesses of certain critical velocities and can undergo a Tscherenkov slowing-down in two steps. (tr-auth)

34983 A RAPID SCAN SPECTROGRAPH FOR PLASMA SPECTROSCOPY. R. A. Hill and E. H. Beckner (Sandia Lab., Albuquerque, N. Mex.). Appl. Opt., 3: 929-32(Aug. 1964).

A scanning spectrograph with a spectral scan speed of from 10 to 200 Å/μsec and a scanning range of 210 Å is described. This spectrograph was used to obtain time-resolved H_α, H_β, and H_γ line profiles, and line-to-continuum ratios, in a shock-heated hydrogen plasma. Electron densities were determined at various times behind the shock front from the Stark-broadened lines, and the plasma temperature was obtained from the line-to-continuum ratio. The electron densities obtained from the three lines were found to compare remarkably well. In addition, it was possible to utilize the Saha equation and correlate the time behavior of the electron density with the temperature and atom density measurements. (auth)

34984 LABORATORY MEASUREMENTS OF PLASMA TRAPPING WITHIN THE MAGNETOSPHERE. F. J. F. Osborne, M. P. Bachynski, and J. V. Gore (RCA Labs., Montreal). Appl. Phys. Letters, 5: 77-9(Aug. 15, 1964).

The interaction of the solar wind with the magnetosphere was simulated by the interaction of a shock-driven barium plasma with a three-dimensional dipole magnetic field at the equatorial plane of the earth model. Compression of the magnetic field on the windward side resulted in a deformed magnetic cavity, within which discrete visible regions of plasma were observed. The behavior and properties of the trapped plasma were investigated. (D.C.W.)

34985 PROPERTIES OF A QUANTUM PLASMA IN A UNIFORM MAGNETIC FIELD. John J. Quinn (Chalmers Tekniska Högskola, Goteborg and RCA Labs. Ltd., Zurich). Arkiv Fysik, 26: 93-126(1964).

A number of different effects which depend on the self-consistent response of a quantum plasma in the presence of a d.c. magnetic field to a small electromagnetic disturbance with arbitrary space and time dependence are reviewed. The general method for deriving the quantum mechanical conductivity tensor of a degenerate electron gas is presented, and some simple generalizations of it are discussed. Applications to many of the well known effects are briefly treated, with reference to the literature for further details. It is pointed out how wide a variety of effects can be treated as special cases once the general expression for the conductivity has been derived. (auth)

34986 MICROWAVE EMISSION FROM A CYLINDRICAL PLASMA. P. Weissglas. Arkiv Fysik, 26: 185-91 (1964).

It is shown that obliquely emitted TM waves are obtained with the same frequency spectrum as obliquely emitted TE waves (TE and TM refer to polarizations when the axial component of the electric or magnetic field is equal to zero, respectively), using the basic idea that thermal fluctuations will not only excite collective oscillations in phase along the cylinder column but also oscillations with arbitrary phase in this direction. Calculations, which support the suggestion that fluctuating electric fields directed along the axis will be generated and show that a radiation field with nonzero electric vector along the axis is produced, are presented. (L.B.S.)

34987 HEAT AND MOMENTUM BALANCE OF A PLASMA SLAB. Bo Lehnert (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 26: 407-21(1964).

The heat and momentum balance is determined for a plasma slab situated between two parallel electrode surfaces. A magnetic field is directed along the latter and is immersed in the plasma. Further, a potential difference

is applied across the slab and the velocity and temperature distributions are deduced in a stationary state, under the influence of viscous dissipation and heat conduction. For temperatures in the million degree range and for densities and linear dimensions which apply to actual experimental conditions, the energy losses due to heat conduction are found to be much greater than those produced by bremsstrahlung and cyclotron radiation from a pure hydrogen plasma. As far as orders of magnitude are concerned the calculated power loss and temperature agree with experiments with rotating plasma devices. In a pure hydrogen plasma the energies of the directed and the thermal motions are found to be of about the same magnitude. This restricts the effectiveness of a plasma confinement by the centrifugal force, even in devices with large radial ratios, r_0/r_w. It is also likely to limit the highest accessible velocity of rotation to the value $(r_0/r_w)(2e\phi_i/m_i)^{1/2}$, where ϕ_i is the ionization potential of the gas. Finally, for very strong magnetic fields and large linear dimensions the flux of particles to the end insulators of a rotating plasma device produces a higher energy loss than that originating from transverse heat conduction. (auth)

34988 ON THE NONLINEAR THEORY OF ELECTRON CYCLOTRON RESONANCE. A. N. Kondrashenko. At. Energ. (USSR), 16: 399-402(May 1964). (In Russian)

A survey is made of the influence of nonlinear effects on the electron cyclotron resonance in a plasma. Basic consideration is given to a determination of the maximum speed acquired by the plasma electrons. (tr-auth)

34989 ON INSTABILITIES OF ELECTRON LANGMUIR OSCILLATIONS OF A PLASMA IN A MAGNETIC FIELD. V. N. Oraevskii. At. Energ. (USSR), 16: 441-2(May 1964). (In Russian)

It is shown that, in a plasma in a magnetic field with known relations between the plasma parameters, instability of the stationary electron Langmuir waves arises, in addition to the instability with no magnetic field. These Langmuir waves decay into electromagnetic waves. The wave instability is investigated for not too large amplitudes. The expression for the increment of the growth of the perturbation is presented. (M.J.T.)

34990 GRAVITATIONAL STABILITY OF A HOMOGENEOUS EXTENDED DISSIPATIVE PLASMA. J. L. Tassoul (Université Libre, Brussels). Bull. Classe Sci., Acad. Roy Belg. (5), 49: 935-46(1963). (In French)

The gravitational stability of an extended, homogeneous, viscous, and thermally conducting plasma in nonuniform rotation is investigated. It is shown that when the uniform magnetic field and the angular velocity are both at right angles to the direction of a wave perturbation, Jean's criterion is slightly modified by the thermal conductivity, while viscosities and remaining forces have no effect on the appearance of instability. Furthermore, under the same assumptions, it is found that magnetic field and rotation have a stabilizing effect, provided the system is a perfect magnetic gas. A general survey of gravitational stability for such a dissipative plasma is given, regardless of the directions of the magnetic field and angular velocity. (auth)

34991 PROPAGATION OF RADIO WAVES ACROSS A VELOCITY DISCONTINUITY IN A ZERO TEMPERATURE PLASMA. A. Hruška (Geophysical Inst., Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 14: 417-22(1964).

The reflection and refraction of a plane wave on the interface between two plasma regions, one of which is in motion relative to the other, is investigated in nonrelativistic approximation. It is shown that a transverse wave incident on the interface generates reflected and transmitted waves. The intensities of the reflected and transmitted electric fields are calculated. (D.C.W.)

34992 EFFECT OF NEUTRAL PARTICLES ON HIGH-FREQUENCY CONDUCTIVITY OF PLASMA. J. Václavík (Inst. of Plasma Physics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 14: 423-9(1964).

The diagram technique of the temperature-dependent Green's functions is used to study the effect of neutral particles on the high-frequency conductivity of high-temperature plasma in the Born approximation. Assuming that the frequency of the electric field is much larger than the collision frequency of the electrons with neutral particles, expressions are derived for Re $\sigma^{en}(\omega)$ for the case in which the neutral particles and electrons are regarded as hard, elastic spheres and the case in which the neutral particles are hydrogen atoms in the ground state. (auth)

34993 PLASMA CONFINEMENT DEVICE WITH A REVERSED FIELD. [PART] I. Masaru Suglura, Kohei Ogasawara, Masayuki Iguchi, Isao Hirota, Kiyoo Tanaka, and Shuichiro Kawamata. Denki Shikensho Iho, 28: 50-60 (Jan. 1964). (In Japanese)

A plasma confinement device with a reversed stabilizing field is described, and the results of some experiments with the device are given. (D.C.W.)

34994 TRANSVERSE PLASMA WAVES AND THEIR INSTABILITY. PART 2. F. D. Kahn (Univ. of Manchester, Eng.). J. Fluid Mech., 19: 210-20(June 1964).

A dispersion relation is set up for transverse waves in a plasma with an ellipsoidal velocity distribution. It is shown that the most unstable wave has its wave-normal parallel to the shortest axis of the ellipsoid and its vector potential parallel or anti-parallel to the longest axis. The maximum possible amplification rate is then calculated. Ellipsoidal velocity distributions arise in any flow with an anisotropic pressure tensor. If the resulting instability leads to a microscopic redistribution of particle velocities, then the effective transport coefficients of the plasma are changed. In particular, it is shown that the effective viscosity is decreased and becomes dependent on the local gradient of the macroscopic velocity. (auth)

34995 KINETIC EQUATION FOR AN INHOMOGENEOUS PLASMA FAR FROM EQUILIBRIUM. R. Balescu and A. Kuszell (Université Libre, Brussels). J. Math. Phys. (N. Y.), 5: 1140-9(Aug. 1964).

A kinetic equation for a nonuniform plasma is derived from the Liouville equation by a general diagram technique. It describes the evolution of a small spatial inhomogeneity in a plasma the velocity distribution of which is far from equilibrium (and hence time-dependent). The equation is valid for short and long times, within the ring approximation. Its explicit form is obtained by the exact closed solution of a singular integral equation. The kinetic equation is non-Markoffian and, contrary to the corresponding homogeneous equation, keeps a trace of this character even in the limit of long times. Only when the velocity distribution and the two-body correlation function reach thermal equilibrium does the equation reduce to a Markoffian limit. The latter is identical with the kinetic equation derived earlier by Guernsey. The treatment of unstable inhomogeneous plasmas is briefly indicated. (auth)

34996 ENERGY LOSS BY A SEQUENCE OF FAST CHARGES IN A PLASMA. Taro Kihara, Osamu Aono,

and Ryo Sugihara (Tokyo Univ.). J. Phys. Soc. Japan, 19: 986-9(June 1964).

The energy loss by an equidistant sequence of charges moving fast in a straight line is calculated in the unified theory of relaxations in plasmas. The rate of energy loss in the absence of any magnetic field has sharp maxima when $s\Omega$ is equal to the plasma frequency, Ω being the frequency of the periodic passage, and s being any integer. (auth)

34997 SIMILARITY SOLUTIONS FOR TRANSIENT PINCHED PLASMA. [PART] II. Sinzi Kuwabara (Tokyo Univ.). J. Phys. Soc. Japan, 19: 989-94(June 1964).

A magnetohydrodynamic theory of transient pinched discharge is presented. A cylinder of a perfectly conducting plasma initially submerged in a uniform axial magnetic field is compressed impulsively by an extremely strong external magnetic pressure. Two types of induced magnetic field are considered. One is due to an axial sheet current on the plasma surface and the other due to an outer coil current. By assuming the occurrence of a converging shock wave, the similarity-solution method is applied for the analysis. The results obtained indicate that the presence of magnetic field in a plasma seems to have a preventing effect on the compression. (auth)

34998 STRUCTURE OF PLANE SHOCK WAVE IN PLASMA. Keishiro Niu (Osaka Univ.). J. Phys. Soc. Japan, 19: 999-1009(June 1964).

The structure of a plane shock wave which propagates in a plasma without magnetic fields is investigated by using the fully ionized model of the ion and the electron gases. The transport equations are of the Navier-Stokes type, the viscosity of the ion and the thermal conductivity of the electron being taken into account. To calculate the collision terms in the shock region, the Mott-Smith type and the local equilibrium type are assumed for the distribution functions of the ion and the electron respectively, and the Fokker-Planck equation is employed. This formulation can always give the continuous solutions which do not miss a physical meaning for all Mach numbers. In addition, the three-fluid model which improves the transport equations for the ion is proposed and the alternative forms of considering the electron momentum are also derived. (auth)

34999 AN EXPERIMENTAL STUDY OF THE USE OF A LANGMUIR PROBE TO MEASURE ELECTRON TEMPERATURES AND DENSITIES IN AFTERGLOWS. G. R. Court and J. Sayers (Univ. of Birmingham, Eng.). J. Sci. Instr., 41: 462-4(July 1964).

The factors that can affect the reliability of probe measurements in afterglows are discussed. It is concluded from measurements made in nitrogen afterglows that the main source of error is the variation of plasma potential with probe current, which falsifies the electron temperature measurements. An electron source (a heated tungsten filament) was used in the afterglow in an attempt to remove this source of error, and it is concluded that this technique makes the probe measurements reliable. It was also found that the electron source maintained the afterglow electron temperature at a value close to the source temperature. By varying both the source temperature and the total gas pressure, afterglow electron temperatures between 1000 and 2600°K were obtained in ammonia–helium gas mixtures. (auth)

35000 A METHOD OF MEASUREMENT OF PLASMA CONDUCTIVITY. I. THEORETICAL APPROACH. Hiroshi Tanaca and Mikiko Hagi (Yokohama National Univ., Japan). Japan. J. Appl. Phys., 3: 335-7(June 1964).

It is shown that the plasma conductivity can be evaluated from the change induced in the magnetic flux in the plasma by an applied electromagnetic field. The evaluation requires no detailed knowledge of the electron collision frequency. (auth)

35001 A METHOD OF MEASUREMENT OF PLASMA CONDUCTIVITY. II. EXAMPLE OF MEASUREMENT. Hiroshi Tanaca and Mikiko Hagi (Yokohama National Univ., Japan). Japan. J. Appl. Phys., 3: 338-41(June 1964).

A measurement of plasma conductivity is described, based on the method theoretically discussed in the preceding article. The plasma tube is inserted in a single turn coil of a LC oscillator, and the shift in the resonance frequency, Δf, due to the insertion is observed. From Δf the change in the magnetic flux penetrating the coil can be evaluated, and from the latter the plasma conductivity can be determined. The results are in satisfactory agreement with the conductivity values obtained by the usual probe method. (auth)

35002 REMARKS ON THE EXTENDED RANDOM-PHASE APPROXIMATION. A. K. Rajagopal (Inst. of Mathematical Sciences, Madras). Nucl. Phys., 57: 435-43 (Aug. 1964).

A systematic approximation scheme (extended random-phase approximation) is developed by means of the Green function method and is applied to the case of plasma oscillations in an electron gas. This derivation is compared with similar attempts. (auth)

35003 EFFECT OF COMPRESSIBILITY ON KELVIN-HELMHOLTZ INSTABILITY IN A PLASMA. Amiya K. Sen (Columbia Univ., New York). Phys. Fluids, 7: 1293-8 (Aug. 1964).

The problem of stability of the most general type of Kelvin-Helmholtz discontinuity in a compressible plasma was formulated. It is found that unlike surface tension, gravity, and magnetic fields, compressibility can have either stabilizing or destabilizing effect, depending on the stationary state of motion. In general, this may lead to two domains of stability, in contrast to only one that exists in the case of incompressible plasma. Compressibility will have a stabilizing or destabilizing effect, if the streaming speed is sufficiently larger or smaller, respectively, than the magnetoacoustic speed. (auth)

35004 COUPLING OF MAGNETOHYDRODYNAMIC TO ELECTROMAGNETIC AND ACOUSTIC WAVES AT A PLASMA-NEUTRAL GAS INTERFACE. Sheldon L. Kahalas and Dale A. McNeill (Mt. Auburn Research Associates, Inc., Cambridge, Mass.). Phys. Fluids, 7: 1321-8(Aug. 1964).

The coupling of magnetohydrodynamic waves to electromagnetic and sound waves at a plane interface between a plasma and a neutral gas is considered for arbitrary direction of the incident wave vector and for the constant external magnetic field lying either in the plane of incidence or perpendicular to it. The relations between the angle of incidence, reflection, and transmission, the ratio of the field amplitude transmitted or reflected to the corresponding amplitude incident, and the energy coupling coefficients are calculated. An incident fast magnetoacoustic mode generates a sound wave with energy coupling coefficient of the order of the ratio of the speed of sound to the Alfvén speed when this ratio is small. An incident slow magnetoacoustic mode generates a sound wave with energy coupling coefficient of the order of unity and an electromagnetic wave with energy coupling coefficient of the order of the ratio of the speed of sound to the speed of light. (auth)

35005 MAGNETOGASDYNAMIC BOUNDARY CONDITIONS AT A CONDUCTING WALL. T. E. Luzzi and R. A.

Gross (Columbia Univ., New York). Phys. Fluids, 7: 1329-38(Aug. 1964).

Velocity boundary conditions at a conducting wall were developed for the continuum magnetogasdynamic equations. The wall is separated from the fully ionized plasma by a Langmuir type sheath. The effects of the sheath on the single fluid plasma boundary conditions are studied for the case where the particle gyro period is large compared to its flight time across the sheath. The effects of chemistry and heat transfer in the vicinity of the wall are ignored. For the case where the wall potential is greater than the plasma it is possible to have a slip velocity at the wall where no-slip would occur in an equivalent un-ionized gas flow. The magnetohydrodynamic equations were solved with the above boundary conditions for the case of plasma flow between two parallel conducting plates held at a potential difference. The lower potential plate (cathode) is a thermionic current emitter. Depending upon the potential difference between the plates and the cathode thermionic emission current, the anode potential is either greater than that of the plasma and slip occurs or less than that of the plasma and no-slip occurs. Slip no-slip criteria are presented for the flow of plasma over many bodies, some of which are cathodes and the others anodes. (auth)

35006 EXPERIMENTS ON MAGNETOHYDRODYNAMIC SHOCK WAVES. George C. Vlases (California Inst. of Tech., Pasadena and Univ. of Colorado, Boulder). Phys. Fluids, 7: 1358-65(Aug. 1964).

Differences in the performance of an inverse pinch electromagnetic shock tube with and without a high degree of preionization are discussed. Only collision-controlled magnetohydrodynamic shock waves are considered. It is found that the flow in the absence of preionization may differ substantially from that when the gas is preheated. Experiments carried out for both cases show qualitative agreement with the theory. (auth)

35007 FLUX TRANSPORT BY A SHOCK PLASMA. J. P. Barach and J. H. Lee (Vanderbilt Univ., Nashville). Phys. Fluids, 7: 1366-71(Aug. 1964).

A magnetic field of about 50 G is observed to be transported downstream from a sharply localized d-c field up to 34 kG interacting transversely with a shock produced plasma flow of velocity up to 2 cm/μsec. The transported flux is found to be antiparallel to the imposed field and to decay exponentially in time as it moves downstream. The decay of the flux gives an estimate of the gas conductivity. The amount of trapped flux is in agreement with an approximate theory in which the decay of the initial trapped flux, the magnetic deceleration of the flow, and the reduction of the conductivity by the magnetic field are considered. The initial trapped flux is found to be proportional to the reduced conductivity and the flow velocity, as expected. However an increase in the imposed field beyond 17,000 G reduces the trapping effect due to reductions in both the conductivity and the exit flow velocity of the plasma. The e-folding time for field decay is roughly 3.5 μsec and does not increase with increasing shock speed. (auth)

35008 ELECTRON CYCLOTRON RESONANCE INSTABILITY IN A MIRROR MACHINE. M. Seidl and P. Sunka (Inst. of Plasma Physics, Czechoslovak Academy of Sciences, Prague). Phys. Letters, 11: 31-2(July 1, 1964).

The electron cyclotron resonance instability of an electron gas confined in a d-c magnetic field of 100 to 400 gauss (mirror ratio 1:2) was studied by electron beam injection. The instability was found to represent an efficient means for trapping of the injected particles. (R.E.U.)

35009 THE RADIAL VARIATION OF PARAMETERS DETERMINING THE VELOCITY OF HYDROMAGNETIC IONISING FRONTS IN A CYLINDRICAL GEOMETRY. L. Sharp and C. N. Watson-Munro (Univ. of Sydney). Phys. Letters, 11: 39-40(July 1, 1964).

Results are given for deuterium, helium, and hydrogen as obtained in the Super II plasma source at Univ. of Sydney. (R.E.U.)

35010 MEASUREMENT OF THE SPECTRAL DISTRIBUTION OF LIGHT SCATTERED BY A θ-PINCH PLASMA. H. J. Kunze, E. Fuenfer, B. Kronast, and W. H. Kegel (Institut fur Plasmaphysik, Garching, Ger.). Phys. Letters, 11: 42-3(July 1, 1964).

The apparatus and results of measurements of scattering of light from a ruby laser, as determined by the spectral distribution of density fluctuations, are given for plasmas of 90,000 and 55,000°K. Line profiles of scattered light are given for different times after discharge in hydrogen, and are compared with theoretical calculations. (R.E.U.)

35011 INTERACTION OF A PLASMA WITH A "HELICAL" ELECTRON BEAM. Jacob Neufeld and Harvel Wright (Oak Ridge National Lab., Tenn.). Phys. Rev., 135: A1175-89(Aug. 31, 1964).

The behavior of a plasma-beam system immersed in a magnetic field B_0 is investigated theoretically under the assumption that the electrons comprised in the beam have helical trajectories coaxial with B_0. The beam is designated as helical. The plasma-beam system is examined for instabilities which result in growing transverse waves aligned in a direction parallel to that of B_0. Two classifications of instabilities are introduced. In accordance with one of these, the instabilities can be superluminous, subluminous, or counterstreaming, depending on direction and velocity of the excited wave. The other classification differentiates between excited P and B waves and is based on the comparison of some of the waves excited by the beam and the corresponding waves which can be radiated by a single particle in the unperturbed plasma. If the beam is linear (not helical), i.e., if the electron trajectories in the beam are parallel to B_0, there is only one type of instability (P instability) in which the frequencies of the waves excited by the beam differ very little from the frequency of the corresponding waves which can be radiated by a single particle in the undisturbed plasma. On the other hand, if the beam is helical there is an additional instability (B instability). The latter instability occupies a relatively wide frequency range in the neighborhood of the corresponding P instability and represents a continuation of the P instability along the frequency axis. When the intensity of the helical beam is sufficiently small, the P instability is strong and the B instability is weak, i.e., the rate of growth of the B waves is relatively small. Physical conditions under which different types of instability may occur are discussed and the above types of plasma-beam instabilities are investigated with particular reference to the frequency ranges and rates of growth of the excited waves. It is shown that a P instability is always multiple, i.e., there are at least two excited waves having different frequencies which are aligned in the direction of the magnetic field. (A multiple P instability does not occur if the beam is linear.) The character of the multiple P instability is analyzed for various transverse and longitudal velocity components of the electrons in the beam. Using a graphical analysis of the dispersion equation for the plasma-beam system in the ω-k plane (where ω is the frequency and k is the wave number), it is found that superluminous and sub-

luminous instabilities are convective, whereas counter-streaming instabilities are nonconvective. (auth)

35012 INTENSE 584-Å LIGHT FROM A SIMPLE CONTINUOUS HELIUM PLASMA. C. A. Jensen and W. F. Libby (Univ. of California, Los Angeles). Phys. Rev., 135: A1247-52(Aug. 31, 1964).

A simple source for the production of continuous cold plasmas and intense line spectra associated with a particular gas is described in its application to helium. Plasma densities and temperatures were measured spectroscopically. When using helium or neon gas the device becomes an intense source of ionizing radiation for studies of the chemical reactions induced by the ionizing ultraviolet. The intensity of this radiation was measured with reasonable accuracy by very simple photocells which are easily constructed and are only sensitive to vacuum-ultraviolet radiator; more than 10^{16} 584-Å photons per second are emitted by a 30-w source. The mechanism is via ion-electron recombination from a 1660°K plasma of $\sim 10^{13}$ ions/^{3}cm density. (auth)

35013 TIME-SPACE RESOLVED EXPERIMENTAL DIAGNOSTICS OF THETA-PINCH PLASMA BY FARADAY ROTATION OF INFRARED He–Ne MASER RADIATION. Arwin A. Dougal, John P. Craig, and Robert F. Gribble (Univ. of Texas, Austin). Phys. Rev. Letters, 13: 156-8 (Aug. 3, 1964).

A method for time-space resolved measurements on dense, high-temperature plasma in a theta pinch by observation of the Faraday rotation of 3.39-μ infrared He–Ne maser radiation is described. A 2-mw He–Ne gas-phase maser is used. (D.C.W.)

35014 OBSERVATION OF BURNOUT IN A STEADY-STATE PLASMA. Igor Alexeff and R. V. Neidigh (Oak Ridge National Lab., Tenn.). Phys. Rev. Letters, 13: 179-81(Aug. 10, 1964). (ORNL-P-89)

Observations are reported which support a previously developed model predicting the conditions for burnout in a steady-state plasma. The correct dependence of the gas density at which burnout occurs on the power input was observed, and it was verified that many of the gas atoms were ionized in the burnout condition. It was also found that the emission of spectral lines in deuterium and helium plasmas virtually ceases in the burnout condition. (D.C.W.)

35015 MICROWAVE INTERACTIONS IN CRYOGENIC AFTERGLOW PLASMAS. P. D. Goldan, J. A. Berlande, and and L. Goldstein (Univ. of Illinois, Urbana). Phys. Rev. Letters, 13: 182-4(Aug. 10, 1964).

Microwave cross modulation and quenching of the afterglow light intensity were observed in helium plasmas for which the parent gas was maintained at 4.2 and 77°K and in neon plasma for which the gas was maintained at 77°K. Significant deviations from previous observations were noted. (D.C.W.)

35016 COLLISIONLESS DAMPING OF ELECTROSTATIC PLASMA WAVES. J. H. Malmberg and C. B. Wharton (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev. Letters, 13: 184-6(Aug. 10, 1964).

Heavy exponential damping of plasma waves was experimentally observed under conditions for which collisional damping is negligible. Assuming a reasonable plasma temperature, the magnitude of the damping and its dependence on the phase velocity agree with Landau's theory. (D.C.W.)

35017 RECENT DEVELOPMENTS IN CONTROLLED FUSION. A. S. Bishop. Phys. Today, 17: 19-26(Mar. 1964). (MATT-241)

A review of the major approaches to controlled fusion is given. Comparison is made of the status of each approach, with an indication of progress made in the last two years. A discussion of the stellerator concept is also presented. (L.B.S.)

35018 MONOLIQUID DYNAMIC EQUATIONS FOR PARTIALLY IONIZED GAS IN A STRONG MAGNETIC FIELD. E. G. Sakhnovskii. Prikl. Mat. i Mekhan., 28: 474-82(May-June 1964). (In Russian)

A closed equation system that describes transport relations in a partially ionized plasma in a strong magnetic field was constructed as an integral function. The system was generalized for isotropic magnetohydrodynamic, single-fluid completely ionized gas dynamics and weakly ionized gas flow. The equations were constructed for the case of a monatomic gas with elastic collisions and particle pair collisions (including coulomb). It was assumed that the macroscopic parameters vary slightly with free-path length and collision frequency. It was also assumed that the temperature $T_e = T_i = T_\alpha = T$ (electron, ion, or neutral particle temperatures) and that $\sqrt{m_e/m_i} \ll 1$. The gas is assumed to be electrically quasi-neutral. (R.V.J.)

35019 RADIATIVE TRANSFER OF DOPPLER BROADENED RESONANCE LINES. [PART] II. A. G. Hearn (United Kingdom Atomic Energy Authority, Culham, Berks, Eng.). Proc. Phys. Soc. (London), 84: 11-18(July 1964). (CLM-P-37)

The solution of the equation of transfer of radiation for Doppler-broadened resonance lines emitted by a two-level atom in a uniform plane parallel plasma was obtained, allowing for the variation of the source function in frequency and angle. This solution is compared with that obtained by assuming the source function is constant in frequency and angle (complete redistribution). The line profiles and total line intensities calculated from the constant source function solution agree to within 10% with the profiles and intensities obtained from the exact solution. (auth)

35020 FREE-SPACE MICROWAVE TECHNIQUES FOR PLASMA MEASUREMENTS. M. P. Bachynski and G. G. Cloutier (RCA Victor Co., Ltd., Montreal). R C A Rev., 25: 168-99(June 1964).

Three experimental microwave arrangements—a simple source and receiver, a lens transmitter and lens receiver system, and a lens transmitter with a simple receiver—were studied at X-band (10 Gc) frequencies for application to measurements of the properties of a plasma in the configuration of a finite slab. The effects of stray scattering, diffraction, source directivity, plasma container, and multiple reflections for each arrangement were examined. Based on these measurements, the optimum arrangement was used to study transmission and reflection of electromagnetic waves by a slab of plasma in order to ascertain the best arrangement for measuring the properties of the plasma. Of the three microwave arrangements, only the lens-transmitter–lens-receiver system, if used with suitable precautions, appears to be acceptable for measuring the properties of a plasma in the configuration of a finite slab by free-space propagation of electromagnetic waves. (auth)

35021 DOUBLE-PROBE METHOD FOR UNSTABLE PLASMAS. Francis F. Chen (Princeton Univ., N. J.). Rev. Sci. Instr., 35: 1208-12(Sept. 1964).

In order to check the accuracy of electron temperature measurements by the Langmuir probe method in a plasma with large fluctuations in space potential, a method was used which employs a floating probe in addition to the

usual biased probe. The results show that the oscillations do not noticeably affect temperatures found by the standard method, so that it is not usually necessary to use this two-probe time-resolved method even in the presence of fairly large oscillations. Furthermore, the usefulness of this method in the case of an inhomogeneous plasma is illustrated. (auth)

35022 MODULATED REFLECTION PLASMA INTERFEROMETER. L. C. Robinson (Univ. of Sydney). Rev. Sci. Instr., 35: 1239-40(Sept. 1964).

An interferometer with twice the usual sensitivity to plasma electron density changes is described. A wave from an antenna is propagated through the plasma to a diametrically opposite antenna where it undergoes an amplitude-modulated reflection and returns through the plasma. The modulated reflected signals were detected for antenna separations exceeding 4 feet and is clearly suitable for thick plasma. (C.E.S.)

35023 PARTICLE LOSSES AND THE CONFIGURATION OF THE PLASMA JET MOVING ALONGSIDE A CURVED MAGNETIC FIELD. G. M. Batanov, M. A. Ivanovskii and I. S. Shpigel (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 46: 1915-17(May 1964). (In Russian)

Previous studies on the motion of a plasma jet in a curved magnetic field revealed that the elementary theory developed by G. Schmidt does not describe the true conditions; therefore, the configuration and the particle losses in a plasma moving in a homogeneous magnetic field were further investigated. It was found that in any given section the plasma jet consists of a nucleus of dense plasma, possessing a dielectric permeability of about 10^3, moving alongside the lines of force, and of a plasma tongue, emitted transversally with respect to the field. The jet created by the plasma gun placed in front of a magnetic mirror-machine, passed in succession through a portion of a $H_\perp = 3$ k Oe homogeneous field, a curved field, and a $H_0 = 1$ k Oe homogeneous field. The plasma density in the jet was about 10^{12} cm^{-3} while the electron temperature was 5 to 10 ev. The configuration of the jet was determined by a luminescent screen. As the conditions for a magnetohydrodynamic equilibrium of the plasma were not fulfilled, the movement of the jet was accompanied by the ejection of the plasma transversally with respect to the field; no drift of the plasma nucleus was observed. Leakage of the plasma was found to be smaller than anticipated by the theory of G. Schmidt. (TTT)

35024 NONLINEAR EFFECTS IN AN INHOMOGENEOUS PLASMA. V. B. Gildenburg (Gorkii State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 46: 2156-64(June 1964). (In Russian)

Nonlinear effects occurring as a result of interaction between a high frequency field and a laminar inhomogeneous plasma and due to the presence of a sharp maximum of the potential of the averaged force in the vicinity of the plasma resonance are investigated. It is shown that for a sufficiently large amplitude of the external field E_0 ($E_0 > E_0^{cr}$, $E_0^{cr} \sim \nu^{3/2}$ ν is the electron collision frequency) the concentration distribution in the resonance region acquires the shape of a step. The positions of the weakly sloping and steep parts of the step depends on the direction of the preceding change of the amplitude (hysteresis): if the amplitude increases the dielectric constant ϵ on the sloping part is positive and the transition through point $\epsilon = 0$ occurs in a discontinuous manner. With decrease of the amplitude the discontinuity shifts toward the region $\epsilon < 0$ and on the sloping part ϵ closely approaches zero. The first case corresponds to a sharp increase of the quality factor of quasistatic resonances in objects with a diffuse boundary; in the second case these resonances completely disappear as a result of the screening action of the zero dielectric constant layer. Estimations are presented which show that the nonlinear effects considered may be significant in laboratory conditions as well as in the case when radio waves are reflected from ionosphere layers. (auth)

35025 INTERACTION OF LONGITUDINAL AND TRANSVERSE WAVES IN A PLASMA. L. M. Kovrizhnykh and V. N. Tsytovich (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 46: 2212-20(June 1964). (In Russian)

Kinetic and field equations are obtained by taking into account the interaction between longitudinal and transverse electromagnetic waves. It is shown that nonlinear interactions may result in instability of longitudinal and transverse waves. The case of an isotopic plasma and plasma in the presence of beams is considered. (auth)

35026 HEAT TRANSFER IN COMPLETELY IONIZED NONISOTHERMAL PLASMA IN MOTION IN A CHANNEL WITH A MAGNETIC FIELD. V. V. Gogosov. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 2, 50-9(Mar.-Apr. 1964). (In Russian)

Formulas were developed for completely ionized nonisothermal (identical ion and electron temperatures) plasma moving in a plane channel, considering the velocity distribution, current density, and temperature components across the channel. The formulas also included parameters for external load resistence, Hartman number, and anisotropic transfer coefficients. The influence of the parameters on temperature distribution across the channel was analyzed. (tr-auth)

35027 PARTICLE FLUX AND TEMPERATURE IN PLASMA IN STRONG MAGNETIC FIELD. Yu. M. Aliev and A. R. Shister. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 2, 60-5(Mar.-Apr. 1964). (In Russian)

The transfer processes in a completely ionized electron-ion plasma are investigated for the case in which the mean Larmor radii. Formulas for particle flux and temperature along the field were developed on the basis of kinetic equations, considering the influence of magnetic field on particle collisions. (tr-auth)

35028 ZAGADNIENIA MAGNETOGAZODYNAMIKI. CZESC I. (Problems in Magnetogasdynamics. Part I). Krystyn Bochenek, Anna Brahmer, Ryszard Gajewski, Eugenia Kaczmarek, Piotr Kucharczyk, Andrzej Skorupski, Andrzej Szaniawski, and Andrzej Turski. Wroclaw-Warsaw-Krakow, Ossolinskich State Publishing House of the Polish Academy of Sciences, 1963. 232p.

Magnetogasdynamic problems including an introduction to plasma theory, plasma waves, plasma stability, shock waves, dispersion in plasma, Landau attenuation, magnetogasdynamic equations, magnetogasdynamic flow, and plasma electric conductivity and dielectric constants are considered. The separate sections are title listed only for NSA. (C.E.S.)

For abstracts of individual papers see: 35029, 35030, 35031, 35032, 35033, 35034, 35035, and 35036.

35029 INTRODUCTION TO THE PLASMA THEORY. Ryszard Gajewski and Andrzej Skorupski. p.7-38 of "Zagadnienia Magnetogazodynamiki. Czesc I." Wroclaw-Warsaw-Krakow, Ossolinskich State Publishing House of the Polish Academy of Sciences, 1963. (In Polish)

35030 PLASMA WAVES. Ryszard Gajewski. p.39-56 of "Zagadnienia Magnetogazodynamiki. Czesc I." Wroclaw-Warsaw-Krakow, Ossolinskich State Publishing House of the Polish Academy of Sciences, 1963. (In Polish)

35031 THE THEORY OF PLASMA STABILITY. Andrzej Skorupski. p.57-90 of "Zagadnienia Magnetogazodynamiki. Czesc I." Wroclaw-Warsaw-Krakow, Ossolinskich State Publishing House of the Polish Academy of Sciences, 1963. (In Polish)

35032 SHOCK WAVES AND THEIR NUMERICAL DETERMINATION. Krystyn Bochenek. p.91-121 of "Zagadnienia Magnetogazodynamiki. Czesc I." Wroclaw-Warsaw-Krakow, Ossolinskich State Publishing House of the Polish Academy of Sciences, 1963. (In Polish)

35033 DISPERSION IN PLASMA. LANDAU ATTENUATION. Andrzej Turski. p.123-49 of "Zagadnienia Magnetogazodynamiki. Czesc I." Wroclaw-Warsaw-Krakow, Ossolinskich State Publishing House of the Polish Academy of Sciences, 1963. (In Polish)

35034 DISCUSSIONS OF THE PROBLEMS OF MAGNETOGASDYNAMIC EQUATIONS. Andrzej Szaniawski. p.151-71 of "Zagadnienia Magnetogazodynamiki. Czesc I." Wroclaw-Warsaw-Krakow, Ossolinskich State Publishing House of the Polish Academy of Sciences, 1963. (In Polish)

35035 CERTAIN PROBLEMS IN MAGNETOGASDYNAMIC THEORY OF FLOW. Piotr Kucharczyk. p.173-97 of "Zagadnienia Magnetogazodynamiki. Czesc I." Wroclaw-Warsaw-Krakow, Ossolinskich State Publishing House of the Polish Academy of Sciences, 1963. (In Polish)

35036 ELECTRIC CONDUCTIVITY AND DIELECTRIC CONSTANT OF PLASMA. Anna Brahmer and Eugenia Kaczmarek. p.199-232 of "Zagadnienia Magnetogazodynamiki. Czesc I." Wroclaw-Warsaw-Krakow, Ossolinskich State Publishing House of the Polish Academy of Sciences, 1963. (In Polish)

35037 KINETIC EQUATION FOR A HOMOGENEOUS PLASMA IN A UNIFORM MAGNETIC FIELD. M. J. Haggerty and L. G. de Sobrino (Univ. of British Columbia, Vancouver, Can.). 133p. (CONF-250-21)

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., Aug. 1963.

The theory of Prigogine and Balescu was applied to a homogeneous single-species plasma in a static uniform magnetic field. A kinetic equation was obtained for the one particle velocity distribution, which is assumed initially isotropic in directions perpendicular to the field. The only stationary solutions of the kinetic equation are the Maxwellian equilibrium distributions, and an H-theorem was established. The neglect of "collisions" of the order of duration of one cyclotron period or less (a strong magnetic field approximation) modifies the kinetic equation so that it no longer predicts any relaxation of the velocity components parallel to the magnetic field. The assumptions and approximations of the theory are discussed in some detail. (auth)

35038 COLLISION EFFECTS IN HYDROMAGNETO-IONIC THEORY. Hari K. Sen (Air Force Cambridge Research Labs., Bedford, Mass.) and Arne A. Wyller. 45p. (CONF-471-31)

From American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963.

A hydromagneto-ionic theory was developed within the framework of the Burgers formalism which is a microscopic theory based on moments of the Boltzmann transport equation. The effects on electromagnetic wave propagation of electron-electron and electron proton collisions were considered to the order of Chapman and Cowling's second approximation. The theory includes the effects of ion motions and is applicable to the low frequency modes of wave propagation, such as the whistler, Alfven and the retarded magnetoacoustic modes. Expressions were derived for the refractive index, absorptivity, the wave polarization, and the zeros and infinities of the refractive index. Numerical applications were given for the four characteristic modes of low frequency wave propagation, the whistler mode, lower hybrid frequency, ion gyroresonance, and the hydromagnetic mode. Applications of the theory to the solar corona, and future extensions to the terrestrial ionosphere were indicated. (auth)

35039 ABSORPTION OF LASER LIGHT BY PLASMA. William I. Linlor (Hughes Research Labs., Malibu, Calif.). 7p. (CONF-452-40)

From American Physical Society Meeting, Washington, D. C., Apr. 1964.

Absorption of laser light by plasma produced by a giant pulse was measured for gold and aluminum foils. (R.E.U.)

35040 STUDY OF TURBULENCE IN AN ARC PLASMA JET USING ELECTROMAGNETIC INDUCTION. Allen E. Fuhs (Aerospace Corp., Los Angeles). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-375, 23p. $1.00. (CONF-600-16)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The interaction of a turbulent conducting gas with a steady applied magnetic field drives fluctuating currents. The unsteady magnetic field arising from these currents induces a voltage e in a sensing coil. An integral equation for e and the related partial differential equation for the electrical potential ϕ are derived. A relation between signal rms magnitude and jet properties is discussed. Experiments were conducted using an arc plasma jet operating with argon. Most of the signal was due to frequency components in the interval 10 to 100 kc. By use of two transducers, one located downstream of the other, the average jet velocity was measured. The delay giving the peak value of the cross correlation function formed from the two signals was taken as the transit time. Methods for electronically determining the time delay are described. (auth)

35041 CONTROLLED MODE MICROWAVE PROPAGATION STUDIES IN DENSE PLASMAS. Peter P. Keenan and Frank L. Kelly (Lockheed-California, Co., Burbank). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-377, 10p. $1.00. (CONF-600-38)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

A microwave-plasma diagnostic technique which is compatible with the electrodeless discharge method of plasma generation was investigated. The plasma is created via inductive coupling from an r-f (15-40 Mc) coil into a low pressure gas (Ar). The ionized gas, in effect, approximates the short circuited secondary of the r-f transformer. Thus, high density plasmas are generated. A microwave diagnostic system was developed which permits x-band (8840 Mc) waveguide transmission through this plasma without appreciably loading the r-f coil or disturbing the plasma characteristics. To accomplish this, a TM_{01} waveguide mode is used the waveguide wall currents of which are orthogonal to the r-f exciting coil currents. Thus, axial slots may exist in the waveguide structure which do not impede waveguide transmission and minimize r-f coil loading. The axial slots along with the circular symmetry

of the plasma-waveguide configuration permit controlled mode propagation even in overdense plasmas (plasma in which resonant frequency exceeds the microwave frequency) and also the use of microwave probes which measure the axial variation in microwave field intensity. These microwave probing techniques permit axial plasma profile measurements in relatively dense plasma using simple techniques and a minimum of equipment. Plasma impedance measurements r-f are also used to check the microwave measurements. Experimental measurements of plasma profiles along with correlations between the microwave and r-f impedance measurements are summarized. (auth)

35042 INTERFEROMETRIC STUDY OF THERMAL EQUILIBRATION OF A SHOCK-HEATED PLASMA. Howard Wong (Stanford Univ., Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-376, 5p. $1.00. (CONF-600-39)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The mechanisms for ionization induced by strong normal shock waves in argon were using optical techniques, primarily the Mach-Zehnder interferometer. This nonequilibrium condition in the relaxation region was investigated experimentally by measuring the shift in the fringes due to a change in the refractive index of the medium. Both electron and mass density profiles from the shock front to the equilibrium region were determined. A theoretical analysis on the ionization mechanism was made to explain the measured profiles and relaxation times. Initially, the sensitivity and accuracy of the optical interferometry to electron concentration were studied. For electron concentration greater than 10^{16} cm^{-3}, the technique is quite acceptable. Good agreement was obtained with equilibrium conditions predicted by the Saha equation. For the measurement of electron concentration two wavelengths were required. Interferometric method is attractive in that no assumption on equilibrium of the medium is required to interpret the data. Also, there is no disturbance to the gas conditions as introduced by probes. The analysis for the mechanism of ionization showed that the relaxation region could be divided into three regimes, characterized by efficiencies of different ionization processes. Regime I, the early stage of ionization directly behind the shock front, could be accounted for by argon atom-atom excitation and ionization collisions. A cross-section for this process was determined and appeared to be reasonable when compared to experimental values at higher energies. Photoionization, precursor effects and impurities do not seem to play a pertinent role under the tested conditions. Regime II was determined by electron-atom excitation and ionization collisions as was predicted by Petschek and by Bond. This regime began when the degree of ionization reached 5×10^{-3}. Recombination, which was pertinent as equilibrium was approached, characterized regime III. However, it was found to play a minor role in the determination of the electron profile. The recombination rate constant was determined through detailed-balancing and was found not to be greater than the experimental value. (auth)

35043 A RELATIONSHIP FOR PLASMA SHEATHS ABOUT LANGMUIR PROBES. Richard T. Bettinger and E. Harris Walker (Univ. of Maryland, College Park). 13p. (CONF-452-13).

From American Physical Society, Washington, D. C., Apr. 1964.

An analytical relation for the sheath about a spherical Langmuir probe was empirically derived from calculated data, which are reproduced within a mean error of better than 10% by the relation. A semi-quantitative analysis verified the functional dependence of the relation; a similar analysis gave the corresponding relation for cylindrical geometry. (auth)

35044 COMPUTER MODEL OF A BEAM-GENERATED PLASMA. D. A. Dunn and I. T. Ho (Sanford Univ., Calif.). 50p. (CONF-471-36)

From American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963.

A one-dimensional charge sheet model of an electron beam traveling through a diode and continuously creating electron and ion charge sheets within the diode was analyzed using a computer to follow the motions of the charges during the buildup time to a quasi-equilibrium condition. A step-by-step calculation of the self-consistent field of the charges of the beam and the plasma charges created by the beam was performed, holding the total number of charge sheets constant, but increasing the charge per sheet as more charges were created. A plasma is created that has a density much greater than the beam, and large-amplitude plasma oscillations develop with density variations of both electrons and ions about an average density that has a value roughly in agreement with the prediction of static theory. These oscillations occur in two frequency ranges, with one range near the electron plasma frequency and the other near the ion plasma frequency. (auth)

35045 FERMI-LIQUID EFFECTS IN CYCLOTRON RESONANCE. P. M. Platzman and K. C. Jacobs (Bell Telephone Labs., Murray Hill, N. J.). 23p. (CONF-543-5)

From American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964.

The steady-state properties of transverse, circularly polarized waves propagating along a static magnetic field in a uniform plasma (metal) are considered. Using the Landau theory of Fermi-liquids, the effect of correlations on the reflection properties of a semi-infinite metallic plasma is calculated. The expressions are numerically evaluated and discussed for a range of parameters pertinent to the alkalis. (auth)

35046 ON THE MASTER EQUATION FOR PLASMAS. James E. McCune (Massachusetts Inst. of Tech., Cambridge). 54p. (CONF-452-6)

From American Physical Society, Washington, D. C., Apr. 1964.

A straightforward derivation of the general kinetic equation describing the irreversible evolution of the N-momenta distribution function for a classical spatially homogeneous stable plasma ($\Lambda_D^3 \gg 1$) is given. Collective effects are included. This plasma master equation reduces to the weak-coupling master equation when collective effects are neglected. The results are given first in terms of a coupled pair of equations analogous to those obtained by Bogoliubov for the kinetic description of a plasma. The equation for the generalized correlations is then solved for stable plasma in terms of the N-momenta distribution function; the master equation then follows by substitution, and is shown to possess an H-theorem. The conditions under which these results reduce to the kinetic equation of Balescu and Lenard, are derived. The origins of irreversibility in plasmas are discussed in the light of this and other recent work, and the properties of the stationary solutions of the general kinetic equations are analyzed. (auth)

35047 APPARATUS AND METHOD FOR CONFINING A PLASMA. K. O. Friedrichs and H. Grad (to U. S. Atomic Energy Commission). U. S. Patent 3,141,826. July 21, 1964.

Methods and apparatus for forming a plasma configuration having cusps are described. The apparatus comprises adjacent oppositely energized conductors for applying oppositely directed fields that compress the plasma inwardly. An additional conductor is provided for compressing the plasma from the inside out as opposed to the compression inwardly. Gas is injected into a container for complete ionization, whereupon oppositely directed fields are applied to provide a magnetic field pattern with cusps that cancels at the center of the container and does not enter the plasma. The magnetic field induces a current flow in the surface of the plasma to form a current interface, thereby forming a boundary between the plasma and field to prevent escape of any plasma. Subsequently, the plasma is compressed by rapidly raising the strength of the magnetic fields. (AEC)

Shielding

Refer also to abstracts 33886 and 35091.

35048 (AMRL-TDR-64-11) COMPUTER ANALYSIS OF RADIATION SHIELDING. R. E. Fortney (Northrop Corp. Northrop Space Labs., Hawthorne, Calif.). Feb. 1964. Contract AF33(657)-8762. 89p. (AD-435737)

The purpose of the study was to develop mathematical methods to assess the biological hazards of space radiation and to program these methods for the IBM 7090 using FORTRAN language. A semianalytical approach was utilized to write machine programs for geocentric trajectories and a model astronaut inside a space vehicle. The trajectory program is used to solve the two-body problem with perturbations to correct for the oblateness of the earth. The earth's magnetosphere is the space of principal interest for lunar missions, therefore lunar impact and return trajectories are considered to be two-body geocentric orbits. An astronaut's head and torso are represented by two right elliptical cylinders. This model is placed inside a mathematically described space vehicle with known thicknesses in designated areas. An existent machine program was utilized to define the radiative environment in McIlwain (B,L) coordinates and supplemental computer programs were used to determine radiation doses resulting from electron and proton environments. Results from the CARS program are obtained with a small amount of machine time. For example, one tenth (0.1) of an hour was required to determine the radiation dose due to two spectrs (electrons and protons) at ten points in the model astronaut within the APOLLO Command Module for a given orbital mission. A bibliography of 53 references is given. (auth)

35049 RADIATION PROTECTION AT WALL OPENINGS FOR DUCT OR PIPE. Harrison D. Goodman and George Hollands. Air Conditioning, Heating, Ventilating, 60: 81-4(Feb. 1963).

Reference data for shielding ductwork and other openings that penetrate protective barriers around radiation facilities, particularly x-ray rooms, are presented. (L.B.S.)

35050 A SWEDISH BUILDING MATERIAL FOR LOW-RADIOACTIVITY LABORATORIES. Bo Lindell and Peter Reizenstein (Karolinska Sjukhuset, Stockholm). Arkiv Fysik, 26: 65-74(1964).

Samples of various minerals were measured in search for more convenient building materials to provide both shielding from the environmental radiation and low contents of radioactivity in the material itself. Results confirm the expectation that ultramafic rocks would show less activity than commonly used building materials. Samples of hoforsite and a number of common building materials were measured with a scintillation spectrometer, and the specific activity of the horforsite was found to be much lower than that of the best cement. Spectral curves were obtained for the samples for information with regard to the usefulness of the various materials for radiation shielding purposes in low background laboratories. The specific activity of the concrete samples used in the construction of the new building of the Institute of Radiophysics is given. All results are tabulated. (L.B.S.)

35051 CALCULATION OF THE TRANSMISSION OF SINGLY SCATTERED GAMMA-RAYS THROUGH FINITE THIN SLABS. Iwao Umeda (Technical Research Inst., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 1: 37-40(May 1964).

The intensity and number of singly scattered photons transmitted were calculated for 1.0, 2.0, 4.0, 6.0, 8.0, and 10.0 Mev gamma rays normally incident on slabs of lead, iron, concrete, and water varying from 1 to 4 mean free paths in thickness. Energy buildup factors were obtained by integrating them using Simpson's formula. The calculation for composite shields included 1.0, 3.0, and 6.0 Mev gamma rays normally incident on a lead-water shield. The results obtained show good agreement with the values calculated by the Monte Carlo and the moments methods. (auth)

35052 MONTE CARLO CALCULATIONS ON THE TRANSMISSION OF GAMMA-RAYS FROM ^{60}Co AND ^{137}Cs POINT ISOTROPIC SOURCES IN SPHERICAL AND CYLINDRICAL SHIELDS. Iwao Umeda (Technical Research Inst., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 1: 87-92(June 1964).

For the case of point isotropic source, the number and energy current build-up factors, number of collisions, energy current spectra of γ rays transmitted through spherical and cylindrical shields, and angular distribution through spherical shields were obtained by Monte Carlo calculations. Radiation with energy of 1.25 and 0.662 Mev was assumed to be emitted from the center of an iron and a lead shield varying from 1 to 5 mean free paths in radius. The case histories of 2,000 photons for a spherical shield and 4,000 photons for a cylindrical shield were followed on the IBM 7070 digital computer. Further, a ^{60}Co point isotropic source was placed at the center of a cylindrical plastic scintillator, and pulse height distribution caused by energy absorption was measured for comparison with the Monte Carlo values. The results obtained by the experiment showed good agreement with the results of the Monte Carlo calculation. (auth)

35053 MEASUREMENT OF COHERENT SCATTERING CROSS SECTIONS OF GAMMA RAYS AT SMALL ANGLES. A. Nath and A. M. Ghose (Bose Inst., Calcutta). Nucl. Phys., 57: 547-64(Aug. 1964).

The absolute cross sections for coherent scattering of 0.28-, 0.66-, 1.17-, and 1.33-Mev gamma rays by Pb, Sn, Cu, W, Mo, Hg, Al, and U were measured at very small angles using a new technique. Conventional techniques were used for moderately small angles. Appropriate corrections were made to the measurements. The experimental results were compared with theoretical predictions and previous measurements. The dependence of the cross

sections on the atomic number of the scatterer and the gamma energy was studied. (D.C.W.)

35054 BACKSCATTERING OF GAMMA RAYS FROM IRON SLABS. Haruyuki Fujita, Keisuke Kobayashi, and Tomonori Hyodo (Kyoto Univ.). Nucl. Sci. Eng., 19: 437-40(Aug. 1964).

The spectra of backscattered radiation from finite thick slabs of iron were measured using a scintillation spectrometer. A ^{60}Co gamma point source was placed in close contact with a scattering slab. Variations of number and energy albedo values with increasing the slab thickness are given as experimental formulas and graphical representations. (auth)

35055 POINT-TO-POINT KERNEL ANALYSIS OF AN EXPERIMENT TO DETERMINE WALL PENETRATION OF A SQUAREBASED, CONCRETE STRUCTURE BY GAMMA RADIATION. R. E. Rexroad, M. A. Schmoke, H. J. Tiller, A. Foderaro. L. Degelman, and G. Kowal (Army Nuclear Defense Lab., Edgewood, Md.). Nucl. Sci. Eng., 20: 66-79 (Sept. 1964).

An analysis was made of shielding data obtained from an experiment designed to determine the wall attenuation properties against residual gamma radiation of a simple 12 ft × 12 ft × 8 ft concrete blockhouse for three different wall thicknesses (48, 93.7, and 139 lb/ft^2). Roof thickness was chosen so that radiation scattered through the roof could be considered negligible. A plane source was simulated by successively positioning point isotropic ^{60}Co and ^{137}Cs sources on the ground surrounding the structure. From analysis of a total of 9700 measurements, a point-to-point kernel was developed which permits calculation of the dose rate at any point within the structure from a point isotropic source on the ground outside. Doses calculated from the kernel differ <10 to 50% from the experimental doses, except at extreme angles of incidence where the error can exceed a factor of 2. A computer program was written which integrates the point-to-point kernel over infinite or finite rectangular areas. The kernel was integrated over an infinite area, and results were compared with those obtained from Spencer's theory. It was found that the difference in reduction factor D/D_0 from "experimental" point-to-point kernel data and Spencer's theory did not exceed 40%. Free-field (unshielded detector) dose rates obtained from integrating the point-to-point kernel over ^{60}Co and ^{137}Cs infinite-plane isotropic sources were compared with those obtained experimentally by Rexroad and Schmoke. The difference was found to be 9 and 7%, respectively, for the ^{60}Co and the ^{137}Cs source fields. (auth)

35056 A GENERALIZATION OF THE ENDPOINT METHOD. K. O. Thielheim (Christian-Albrechts Universität, Kiel). Nucl. Sci. Eng., 20: 113-14(Sept. 1964).

A more general endpoint condition is derived from the general solution of an inhomogeneous half-space problem, and a relation between the boundary value of the generalized endpoint method and the albedo of a half space is established. (D.C.W.)

35057 SATURATION BACKSCATTERING OF BETA PARTICLES IN COMPLEX TARGETS. M. F. Laranjeira, F. C. Barreira, and A. M. Brito de Carvalho (Centro de Estudos de Física Nuclear (I.A.C.) and Comissão de Estudos de Energia Nuclear, Lisbon). Rev. Port. Quim. (Lisbon), 5: 113-20(1963).

Experiments on saturation backscattering of β particles of ^{32}P and ^{90}Sr + ^{90}Y were carried out with elements, metallic alloys, salts, and their aqueous solutions, and natural and 99.8% heavy water. Satisfactory correlation was observed between the intensity of the backscattered beam and the equivalent atomic number of the target. Natural and heavy water backscattered identically although several per cent less than the general trend to elements, metallic alloys, and salts. Therefore a small correction for the $\overline{Z}$ values of water, which was also satisfactorily applied to aqueous solutions, was envisaged. (auth)

35058 GAMMA-RAY ATTENUATION COEFFICIENTS. R. G. Rose (Westinghouse Electric Corp., Forest Hills, Penna.). Nucleonics, 22: 126-7(Aug. 1964).

Gamma-ray attenuation coefficients are presented for several shielding materials for gamma energies from 0.1 to 10 Mev. (C.E.S.)

REACTOR TECHNOLOGY

General

Refer also to abstract 33733.

35059 (ANL-6844) CALCULATIONS OF COHERENCE OF FAILURE FOR HYPOTHETICAL MELTDOWN ACCIDENTS IN AN EBR-II-LIKE REACTOR. D. V. Gopinath and C. E. Dickerman (Argonne National Lab., Ill.). Mar. 1964. Contract W-31-109-eng-38. 31p.

In the event of an accident in a fast reactor leading to fuel element failure, the time distribution of meltdown of different fuel elements could play a significant role in the ultimate severity of the accident. Though one could conceive of situations in which the fuel element meltdown leads to reduction in reactivity, it is possible that under certain circumstances fuel element failure is accompanied by the addition of reactivity. In such cases, if many of the fuel elements were to fail simultaneously, or within a short interval of time, the rate of reactivity insertion could be large enough to lead to extremely severe accidents. Hence, in safety analyses for fast reactors it is of interest to study the coherence of fuel element failure and its effect on the further accentuation of the accident. As a step toward such a study, an estimate of the time distribution of failure of fuel elements in different positions of an EBR-II-like core under different hypothetical accident conditions and its possible effects on the rate of reactivity addition is presented. Three different techniques were used for the calculations: (1) ARGUS, a transient heat transfer FORTRAN code for IBM 704 for cylindrical geometry; (2) RP-129H, a space-independent, one-energy group reactor kinetics code with feedback; and (3) an electronic analog. (auth)

35060 (ANL-6904) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, MAY 1964. (Argonne National Lab., Ill.). June 15, 1964. Contract W-31-109-eng-38. 119p.

Progress is reported on: boiling water reactors (BORAX-V), liquid-metal-cooled reactors (fast reactors, fuel development and reprocessing, sodium coolant chemistry, EBR-II, FARET), general reactor technology, advanced systems (AARR, magnetohydrodynamic, regenerative emf cells), and nuclear safety. (D.L.C.)

35061 (DPST-64-83-6) USAEC-AECL COOPERATIVE PROGRAM MONTHLY PROGRESS REPORT, JUNE 1964. H. S. Hilborn, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). July 15, 1964. Contract AT(07-2)-1. 7p.

Irradiation tests of Candu fuel bundles in HWCTR, effects of rod spacing on heat transfer burnout in boiling-light-water-cooled heavy-water-moderated power reactors, and specimen preparation for a study of the orientation of zirconium hydride platelets in thin-walled Zircaloy tubing are discussed. (R.E.U.)

35062 (EURAEC-1138) IMPROVEMENT OF BOILING WATER REACTOR STABILITY THROUGH MINIMIZATION OF BOILING NOISE. Final Report. Lynn E. Weaver (Arizona. Univ., Tucson. Engineering Research Lab.). [1964]. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1311. 121p.

Considerable work has been done in determining the dynamic behavior of boiling reactor systems. One of the limiting factors in the maximum power of boiling reactors is the development of unstable oscillations. Depending upon operating conditions, these reactors have a continuous transition from extremely stable to extremely unstable conditions. Using the well-known transfer function for describing reactor characteristics, it is possible to determine stability. The Bode plot of this transfer function or the reactor frequency response is a measure of reactor stability. Resonant peaks appearing in the reactor frequency response indicate a tendency toward instability. Various techniques can be used in order to obtain the reactor frequency response: the rod oscillation, the reactivity step, and correlation methods. The height of the resonance in the reactor frequency response is related to the statistical characteristics of the output power fluctuation or reactor noise. It is this fact that forms the basis for the study. The goodness criterion that will be used in measuring reactor performance is the minimization of the mean square value of the reactor noise. It can be shown that the mean square value of the reactor noise is related to the height and half width of the resonance appearing in the reactor frequency response. By minimizing the mean square value of the noise in the reactor power output, the resonance in the reactor transfer function can be reduced, thus increasing reactor stability. In the course of this investigation, mathematical models were derived for external feedback reactor control systems, which minimized the reactor noise in the mean square sense and thus increased system stability. Three approaches to the problem, based on the work of Dr. Norbert Wiener, were considered: (1) An analytical approach was used to determine optimum filtering of the reactor noise at some steady state operating point; (2) A method was used, which minimized the system bandwidth subject to a constraint on the mean squared value of the reactor noise; and (3) A graphical technique, which holds the most promise for determining optimum systems to minimize reactor noise is discussed. (auth)

35063 (IG-Report-52) THE PHOSPHATE DELAYED CHROMATE (P.D.C.) METHOD OF CORROSION TREATMENT FOR COOLING WATER CIRCUITS. W. T. Edwards, J. E. LeSurf, and P. A. Hayes (United Kingdom Atomic Energy Authority. Reactor Group. Culcheth, Lancs, England). Apr. 9, 1959. 26p. (NPCC-FEWP/P.691)

An account is given of a method of corrosion treatment for cooling water circuits, which involves an initial clean-up of the circuit with acid phosphate followed by inhibition with potassium chromate at much lower levels than normally used with chromate. In addition to laboratory investigations, the results of plant trials on the auxiliary cooling circuits at Calder Hall, Chapelcross, and Dounreay Fast Fission Reactors are given. Comparative trials show the present treatment to be superior to other inhibitive methods for this application. It is of particular use in small recirculating systems using different metallic, ferrous and non-ferrous, components. (auth)

35064 (ORNL-3626) MOLTEN-SALT REACTOR PROGRAM. Semiannual Progress Report for Period Ending January 31, 1964. (Oak Ridge National Lab., Tenn.). July 1964. Contract W-7405-eng-26. 181p.

Two sections are included; separate abstracts have been prepared for both. (T.F.H.)

For abstracts of individual chapters see: 34050 and 35221.

35065 (STI/DOC/10/28(p.67-71)) SAFEGUARDS METHODS. (International Atomic Energy Agency, Vienna).

A method is described for the non-destructive assay of ^{235}U and Pu in irradiated fuel elements by means of α spectroscopy. An investigation was made of the reliability of a correlation between the amount of tritium found in the reactor heavy water and the power history of a heavy-water-moderated reactor. It was concluded that the tritium activity can be used for measurements of the integral neutron flux and integral power release. It is pointed out that the average integral neutron flux per unit power must be known for the reactor. (C.H.)

35066 (STI/DOC/10/28(p.73-7)) STUDIES INVOLVING REACTORS. (International Atomic Energy Agency, Vienna).

(1) The present status of nuclear power plants is reviewed and future trends are discussed. (2) A method was developed for measuring fast neutron spectra in reactors operating at a low power level. The method is based on the $^{6}Li(n,T)^{4}He$ reaction and the use of semiconductor counters in detecting T and ^{4}He fragments in coincidence. (C.H.)

35067 (STL-372-3) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Quarterly Progress Report for Period Ending March 30, 1964. C. T. Molloy, L. G. Neal, and S. M. Zivi (Thompson Ramo Wooldridge Inc. TRW Space Technology Labs., Redondo Beach, Calif.). Apr. 15, 1964. Contract AT(04-3)-372. 30p.

The stability predictions of various models for hydrodynamic instabilities in boiling water reactors and loops are compared. In-pile capsule experiments on steam-void formation in rapid heating transients are described. A modeling law is derived for use with this type of transient, to permit the simulation of the hydrostatic head above a reactor core by means of a lumped mass. The compressibility of the mass is taken into account. (T.F.H.)

35068 (STL-6312) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Annual Summary Report, 1963. L. B. Wentz, R. W. Wright, and S. M. Zivi (Thompson Ramo Wooldridge Inc. TRW Space Technology Labs., Redondo Beach, Calif.). Dec. 30, 1963. Contract AT (04-3)-372. 179p.

Results are presented of measurements on transient steam-void formation, with particular attention to its applicability as a reactor shutdown mechanism. Emphasis is placed on the study of phenomena that would be important in a destructive excursion, and on periods in the range of 3 to 5 msec. The results, insofar as they are applicable to the self-shutdown of the SPERT-I reactor during a destructive test, are analyzed. An experimental study is also carried out of pressure pulses that occur in reactor power excursions of destructive magnitude. The results are correlated with observed pressure pulses in BORAX-I and SPERT-I. Calculations of the temperature histories in the BORAX-I and SPERT-I excursions are presented, and it is noted that the histories of the pressure pulses in these excursions are consistent with the histories of fuel melting in the cores. (T.F.H.)

35069 (TID-7679) NOISE ANALYSIS IN NUCLEAR SYSTEMS. Proceedings of a Symposium held at the University of Florida, November 4-6, 1963. 4th AEC Symposium Series. (Florida. Univ., Gainesville. Engineering and Industrial Experiment Station). 518p.

Separate abstracts were prepared for 15 of the 28 papers presented; 13 were previously included in NSA (18: 4742, 5845, 7892, 9609, 9639, 9705, 10825, 11377, 11497, 12430, 13193, 15583, and 17330). (R.E.U.)

For abstracts of individual papers see: 35070, 35071, 35072, 35073, 35074, 35075, 35076, 35077, 35078, 35079, 35080, 35155, 35156, 35157, and 35158.

35070 (TID-7679(p.29-59)) STOCHASTIC MODELS FOR FISSION REACTORS. Leslie G. Kemeny and W. Murgatroyd (London. Univ. Queen Mary Coll.).

The process of neutron multiplication in fission reactors is studied on a stochastic as opposed to a deterministic basis. A number of stochastic models are discussed. Prompt- and delayed-neutron probability distributions associated with certain modes of reactor operation are investigated by means of generating-function techniques. (auth)

35071 (TID-7679(p.107-33)) APPLICATION OF POWER SPECTRA TO REACTOR-SYSTEM ANALYSIS. R. L. Randall and C. W. Griffin (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.).

The application of power spectra to reactor-system analysis is discussed. Equipment is described and techniques are outlined for the precise measurement and the analysis of power spectra and cross spectra for the determination of reactor-system parameters and the analysis of dynamic stability. Sample power-spectral-density data are shown to demonstrate that precise measurements of reactor noise at frequencies up to 80,000 cycles/sec can be performed readily with fast detector circuitry, wide-band tape recorders, and commercial spectral analysis equipment. Results of low-frequency studies have demonstrated that cross-spectral-density techniques can be used to measure both the gain and phase components of the transfer functions of a complex power-reactor system with reasonable accuracy even under poor signal conditions. General results also indicate that values of reactor parameters can be determined and theoretical models can be checked and improved from accurately measured reactor-system transfer functions. (auth)

35072 (TID-7679(p.135-54)) SHUTDOWN REACTIVITY MEASUREMENTS USING NOISE TECHNIQUES. M. A. Schultz (Milletron, Inc., Irwin, Penna.).

The theory of obtaining subcritical reactivity by means of power-spectral-density measurements has been known for some time. In practice, measurements to large values of subcriticality have been obscured by bombardment noise and by extraneous instrument noise, and in high-power reactors, by shutdown gamma noise. An experiment was carried out on the cold, clean critical assembly (CES) of the Westinghouse Testing Reactor at Waltz Mill, Pa., to determine how the theory would hold under ideal conditions. Measurements were made down to subcriticalities of -8% for various source, detector, and control-rod configurations. The apparatus was specially constructed to have very low instrument noise, and a hydrogen-filled ion chamber was used to assist in gamma discrimination. (auth)

35073 (TID-7679(p.155-69)) NOISE ANALYSIS OF NUCLEAR REACTOR SYSTEMS IN JAPAN. J. Miida, K. Sumita (Japan Atomic Energy Research Inst., Tokyo); and Y. Kuroda (Tokyo Univ.).

Statistical analysis of nuclear reactor systems has been actively carried out in Japan for the past three years. A review is given of the principal experimental and analytical work in Japan in which noise techniques were used to study nuclear reactor systems. (auth)

35074 (TID-7679(p.171-81)) INVESTIGATION OF NEGATIVE REACTIVITY MEASUREMENT BY NEUTRON-

FLUCTUATION ANALYSIS. C. W. Ricker, D. N. Fry, E. R. Mann, and S. H. Hanauer (Oak Ridge National Lab., Tenn.).

Previous work has indicated the possibility of determining negative reactivities (shutdown margins) by measurement of the spectral density of the neutron fluctuations. These exploratory investigations indicated the desirability of further work aimed at establishing the limits of applicability of the measuring technique employed. A program was set up at Oak Ridge National Laboratory to establish a theoretical and experimental basis for fluctuation measurements. The first goal is the development of a continuous method of measuring negative reactivity by neutron-fluctuation analysis. The preliminary experimental investigation and the research program presently underway at ORNL are described. (auth)

35075 (TID-7679(p.203-18)) REACTOR IMPULSE RESPONSE USING RANDOM SOURCE EXCITATION AND CROSS CORRELATION. T. E. Stern (Columbia Univ., New York).

The measurement of the impulse response of a nuclear reactor by cross-correlation techniques is considered. In particular, excitation by a pulsed-neutron source where the pulses occur randomly in time, their times of arrival being governed by a Poisson distribution, is considered. A review of the cross-correlation method of impulse-response determination is given, and the method of random-pulse excitation is compared with other types of excitation. An experimental technique for the estimation of the cross-correlation function is described. It is particularly suited (but not limited) to situations in which low counting rates may be encountered, i.e., counting rates that are of a magnitude less than the reciprocal of the settling time of the reactor. An analysis of the statistical errors inherent in this method of impulse-response determination is presented. On the basis of this statistical analysis, the efficiency of the method of random pulses is compared with that of the well-known periodically pulsed source technique and with that of random square-wave source excitation. (auth)

35076 (TID-7679(p.219-28)) REACTIVITY MEASUREMENTS USING SOURCE EXCITATION AND CORRELATION TECHNIQUES. Jean Valat (France. Commissariat a l'Energie Atomique. Centre d'Études Nucléaires, Saclay).

The reactivity of a reactor at equilibrium in the subcritical range in spite of noise and insufficient measurement duration is obtained by means of source excitation and correlation techniques. It is assumed that the system is stationary and ergodic, and that the dynamic behavior of the reactor can be approximated by the space-independent kinetic equations. These assumptions are not unreasonable. Methods using periodically pulsed and pseudorandom square-wave neutron-source excitations with cross correlation are now fairly well known. New methods giving a smaller relative statistical error than with previous methods are investigated. (auth)

35077 (TID-7679(p.301-5)) DIGITAL REDUCTION OF DATA IN NOISE ANALYSIS. Ralph G. Selfridge (Florida. Univ., Gainesville).

The construction of a computer code for finding autocorrelations and cross correlations and the associated Fourier transforms, or power spectra, is discussed. The problem is resolved to solving the integral equations for the cross correlation and cross spectral density. (R.E.U.)

35078 (TID-7679(p.321-9)) CORRELATION-FUNCTION ANALYSIS OF SYSTEMS OBEYING LINEAR DIFFERENTIAL EQUATIONS. Maurice Surdin and Constantin Kassimatis (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Saclay).

It is shown that certain techniques of correlation analysis, when applied to linear differential equations, yield interesting results about the physical systems described by these equations. As an illustration of these techniques, the measurement of the reactivity δk of a subcritical reactor is proposed. This application, being quite general, yields as special cases three methods of reactivity measurements recently proposed and also treats a few new ones. (auth)

35079 (TID-7679(p.331-4)) HARMONIC ANALYSIS OF THE INSTANTANEOUS COUNTING RATE OF A PERIODICALLY SAMPLED FLOW OF PULSES. J. Freycenon (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Saclay).

The use of fast fission chambers for transfer-function measurements by the periodic-reactivity-modulation method is considered. The modulated neutron flux is analyzed using a Fourier series and is then measured by the instantaneous counting rate of the pulses delivered by the fission chamber. Periodic sampling of the set of pulses delivered by the detector is made, and the results are stored for analysis in a digital computer. Noise effects are considered. (R.E.U.)

35080 (TID-7679(p.347-55)) STATISTICAL UNCERTAINTIES IN PULSED-NEUTRON AND EXCURSION EXPERIMENTS. Robert W. Albrecht (Washington. Univ., Seattle).

The inherent statistical fluctuations of the neutron density in zero-power stationary multiplying systems are well known and have been measured many times. These fluctuations also enter into nonstationary reactor kinetics experiments. General equations are derived for the variance of the neutron density in systems undergoing transient changes without solving for the distribution itself. The variance is a measure of the statistical uncertainty, which is sufficient for many excursion and pulsed-neutron experiments. The model used assumes a space-independent one-speed multiplying system with no feedback mechanisms. It is further assumed that there is only one group of delayed neutrons and that the reactivity is constant during the excursion. (auth)

35081 STUDY OF TRANSIENT REGIMES OF NATURAL CIRCULATION IN MULTICIRCUIT NUCLEAR REACTOR SYSTEMS. Yu. E. Bagdasarov, O. D. Kazachkovskii, M. S. Pinkhasik, and V. K. Pyshin. At. Energ. (USSR), 16: 407-13(May 1964). (In Russian)

Results are presented of investigations of transient regimes of natural circulation of the liquid metal coolant in triple circuit reactor systems. The basic propositions of the method devised for the calculation are set forth, and results of an experimental study of transient regimes of natural circulation of the coolant in the reactor BR-5 are given. (auth)

35082 ATOMIC ENERGY IN SWITZERLAND. Peter M. Lang (Swiss Federal Inst. for Reactor Research, Wurenlingen, Switzerland). Nucl. News, 7: No. 8, 19-22(Aug. 1964).

Developments in nuclear power in Switzerland are discussed. Currently Swiss power reactor development is concentrated on heavy-water-moderated pressure-tube reactors. Broadening of the Swiss nuclear program has been attained by participation in a number of international endeavors: CERN, Dragon, Halden, and Eurochemic. (P.C.H.)

35083 THE VOID AND HOLE EFFECT IN D_2O MODERATED REACTOR. Yasushi Nakai (Mitsubishi Atomic Power Industry Inc., Saitama, Japan), Osamu Sugimoto, Kinichi Hagioya, Mitsuo Yokota, Yasuhiko Miyasaka, Isao Arase, Shizuo Kikkawa, and Denziro Nemoto. J. Nucl. Sci. Technol. (Tokyo), 1: 11-17(Apr. 1964).

The reactivity change due to an increase in the radius of an empty hole was measured in a heavy water-moderated reactor, and some results differing from experiments with ZEEP were obtained. It was concluded that the streaming in a hole is not so effective for reactivity. In measuring neutron flux in a void, a flat thermal neutron flux distribution was obtained; and it was concluded that the neutrons leaking through the empty hole or the void do not consist of thermal neutrons, but of fast neutrons for the most part. The experimental result of reactivity change due to the void location in the core indicates that the relation between the void location and the reactivity change is independent of the neutron flux distribution. (auth)

35084 METHOD OF PURIFYING A NUCLEAR FUEL SOLUTION. (to Siemens-Schuckertwerke AG). British Patent 963,578. July 15, 1964. Priority date June 9, 1962, Germany.

A method is given for purifying a fuel solution in the circuit of a homogeneous reactor. In this method, the corrosion and fission products are deposited in a region of the circuit where the solution temperature is highest. The wall is insulated to prevent heat losses and thereby increase the wall temperature. The wall may be heated further by a nuclear or chemical process, such as a coating of fissionable material or recombination of the radiolytic H_2 and O_2 products. (D.L.C.)

35085 IMPROVEMENTS IN NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain S.A.). British Patent 963,618. July 15, 1964. Priority date Mar. 9, 1961, Belgium.

A reactor arrangement is described in which the coolant and moderator are kept separate from each other. The moderator is arranged to flow inside tubes which are closed at one end, and the inlet and outlet of the moderator are located at the same side of the reactor vessel. Chambers are provided in the blind ends of the tubes, for containing various parts of the reactor and various connecting and measuring members. (D.L.C.)

35086 NUCLEAR REACTORS. John Alan Dodd (to Societe Anglo-Belge Vulcain S.A.). British Patent 963,791. July 15, 1964. Filed Jan. 11, 1962.

A reactor core is designed in which criticality is controlled by varying the neutron moderation. The core comprises a central stationary fuel unit and a plurality of rotary drum-shaped fuel units surrounding the central unit. The rotary units each have three eccentric sectors which are respectively neutron-multiplying (fuel), neutron-moderating, and neutron-absorbing (fertile material) regions. The units are rotated to control the reactivity during the core lifetime, and thus no large control rods are required, which may be of advantage in marine propulsion. (D.L.C.)

35087 ADJUSTABLE FUEL AND REFLECTOR ELEMENT LATTICE FOR NUCLEAR REACTORS. Eric Aranovitch, Pierre Bonnaure, and Guido Mollica (to Communaute Europeenne de l'Energie Atomique (EURATOM)). British Patent 964,840. July 22, 1964. Priority date Sept. 4, 1961, Germany.

An improved adjusting device is designed for adjusting the relative positions of fuel elements and/or reflector screens within a reactor. The device comprises two sets of guide bars crossing one another at 90° in superposed planes. Each of the bars comprises two parallel parts with spaces therebetween. Carriages are slidably supported by the bars of one set, engaged into the spaces of the other set, and adapted to support the fuel elements and/or screens. The bars of each set are connected at their ends to displacement mechanisms such as articulated rhombuses. (D.L.C.)

35088 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock & Wilcox Ltd.). British Patent 965,535. July 29, 1964. Filed Aug. 16, 1960.

A gas-cooled, graphite-moderated reactor is designed with a horizontal, cylindrical moderator block assembly. Means are provided for bracing the blocks laterally against one another; the means comprise arcuate wedges surrounding the block assembly and springs for urging the wedges against the assembly. (D.L.C.)

Auxiliaries and Components

Refer also to abstract 34734.

35089 (TID-8540(p.177-211)) IN-CORE INSTRUMENTATION. L. R. Boyd (General Electric Co. Atomic Products Div., [Cincinnati]).

In-core instrumentation technology is reviewed, with emphasis on aspects peculiar to in-core measurements. Radiation, pressure, velocity, and temperature measurements; fission-product detection; telemetry; and instrumented fuel assemblies are considered. A bibliography of 33 references is presented. (R.E.U.)

35090 (ANL-Trans-52) DESCRIPTION OF THE INSTABILITY-LOOP OF THE AEG-ATOMIC POWER LABORATORY IN GROSSWELTZHEIM (NEARBY KAHL). (Allgemeine Elektrizitätsgesellschaft, Frankfurt am Main). Translated by Elmar K. Wilip (Argonne National Lab., Ill.). Feb. 25, 1963. 17p.

The design of an instability loop that simulates the flow conditions in the cooling channel of a boiling water reactor is presented. An attempt was made to adjust the geometry of the experimental loop as close to the reactor geometry as possible. The heater, pressure vessel, return flow pipe, mixing chamber, forced-circulation pump, condenser, supercooler, and instrumentation are described. (C.E.S.)

35091 (JPRS-25467) REACTOR-SHIELDING PHYSICS. Translation of p.193-8; 260-70 of "Voprosy Fiziki Zashchity Reaktorov," (a publication of Gosatomizdat, 1963). 25p. (TT-64-31739)

Separate abstracts were prepared for the two papers included. (R.E.U.)

For abstracts of individual papers see: 33886 and 35092.

35092 (JPRS-25467(p.1-8)) PROTECTIVE PROPERTIES OF CERTAIN TYPES OF CONCRETE. V. N. Avaev (Avayev), G. A. Vasil'ev (Vasil'yev), A. P. Veselkin, et al. Translated from p.193-8 of "Voprosy Fiziki Zashchity Reactorov."

Properties of Portland, magnesia, boron-containing Portland, magnetite, datolite, common chamotte, boron-containing chamotte, and serpentine as reactor biological shields are discussed. Neutron and gamma attenuation cross sections are given. (R.E.U.)

35093 THE WELDING WITH MONEL AND INCONEL AT THE FABRICATION OF STEAM GENERATORS FOR A NUCLEAR REACTOR. C. A. A. van der Woude. Lastechniek, 30: 63-71(1964).

The primary system of the considered nuclear reactor was constructed out of corrosion-resistant materials. The conduit-pipes consist of austenitic stainless steel (type 304); the pipe cluster was made from Monel. Other parts of the primary system were provided with a welded layer of Monel. The welding of the Monel cladding, the connection of the Monel pipes with the Monel cladding, and the welds of the transition-tubelures are described. (NPO)

35094 IMPROVEMENTS IN OR RELATING TO COUPLINGS. (to General Dynamics Corp.). British Patent 963,955. July 15, 1964. Priority date Nov. 7, 1961, United States.

A coupling mechanism is designed for releasably connecting a control rod to a control rod drive in a reactor. The mechanism has a bayonet-type female coupling member for attaching to the male coupling member of the control rod. The coupling and uncoupling operations of the mechanism are described. (D.L.C.)

35095 IMPROVED MECHANISM FOR TRANSFERRING ARTICLES. (to General Dynamics Corp.). British Patent 964,051. July 15, 1964. Priority date Aug. 2, 1961, United States.

A transfer device is designed for the handling of fuel elements in a reactor. The device comprises a grappler with upper and lower body portions, means for rotating and moving the lower portion relative to the upper portion, a plurality of grappler hooks carried by the lower portion, and grappler hook actuating means. (D.L.C.)

35096 IMPROVEMENTS IN OR RELATING TO BLOCK STRUCTURES. Philip Cloudesley Warner and Leslie James Knight (to Atomic Power Constructions Ltd.). British Patent 964,081. July 15, 1964. Filed Nov. 9, 1959.

A graphite core assembly is designed for gas-cooled reactors. The assembly comprises layers of non-abutting blocks sandwiched between layers of abutting tiles. In order to make this assembly easier to fabricate and assemble, spigot arrangements are provided at the contacting principal faces of the tiles and the end faces of the blocks. Each spigot arrangement comprises a circular spigot formed on one face and a corresponding circular cavity in the contacting face, the spigot and cavity being formed eccentrically with respect to the axial hole which they surround. The eccentricities of the spigots and cavities of the tiles in any one layer are at right angles to these of their abutting neighbors. (D.L.C.)

35097 SUPPORTING-POST FOR THE SOLID MODERATOR PILE OF A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). British Patent 964,628. July 22, 1964. Priority date Oct. 26, 1961, France.

A supporting post for use at the periphery of a vertical moderator pile, is designed to prevent the bending of the moderator columns due to deformation of the base plate on which the pile rests. The supporting post comprises a rigid central part and a peripheral part of annular metal elements surrounding coaxially the central part. The ends of the post are designed with conical shapes so that a multiplicity of posts can be stacked one atop another, and longitudinal grooves are provided in the exterior surfaces for keying the posts to the rods of the moderator pile. (D.L.C.)

35098 IMPROVED NUCLEAR REACTOR FUEL HANDLING SYSTEM. (to General Dynamics Corp.). British Patent 964,679. July 22, 1964. Priority date Aug. 2, 1961, United States.

An apparatus is designed for charging a reactor with fuel elements and for removing and canning spent fuel elements. The apparatus includes a housing, a grapple movable vertically in the housing and having gripping members, means for raising and lowering the grapple, and means for actuating the gripping members. The operation of the charge and canning machines is described. (D.L.C.)

35099 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Licentia Patent-Verwaltungs GmbH). British Patent 965,536. July 29, 1964. Priority date Nov. 24, 1959, Germany.

A boiling reactor is designed with an improved containment vessel for pressure reduction in the event of rupture of the reactor circuit. The vessel is divided by a partition into two compartments, with the reactor being located in the lower compartment and the upper compartment being filled with water. The partition has a plurality of bores closed in such a way that water passage is prevented while steam is allowed to pass from the lower to the upper compartment. The emergency condenser of the primary circuit is also located in the water body in the upper compartment. (D.L.C.)

35100 IMPROVEMENTS IN OR RELATING TO SUPPORT STRUCTURES FOR VERTICALLY-STACKED SOLID MODERATOR BLOCKS OF A NUCLEAR REACTOR. Pierre Rouge (to Commissariat â l'Energie Atomique). British Patent 965,816. Aug. 6, 1964. Priority date Apr. 14, 1961, France.

A support structure is designed for a vertical stack of graphite blocks. The structure comprises a rigid central support member and a series of rigid concentric supporting rings. The central member and rings rest on struts and are connected to one another by pins engaging in radial slots so that adjacent rings can move or deform slightly relatively to each other. (D.L.C.)

35101 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Robin Pearson and John Oliver (to Nuclear Power Plant Co. Ltd. and AEI-John Thompson Nuclear Energy Co. Ltd.). British Patent 965,843. Aug. 6, 1964. Filed Sept. 10, 1962.

A graphite core construction and support within a concrete pressure vessel is designed which reduces lattice pitch changes. The core comprises a vertical stack of graphite brick columns supported on a plurality of separate spaced pedestals, and means engaging the core periphery to give lateral support to the core. The means comprises a plurality of vertical members disposed around the core, each member having an attached structure which supports a section of the core periphery. Since the pedestals do not form a single unit, sagging is eliminated. (D.L.C.)

35102 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Donald Mason Sutherland (to The Nuclear Power Co. Ltd. and AEI-John Thompson Nuclear Energy Co. Ltd.). British Patent 965,977. Aug. 6, 1964. Filed Aug. 8, 1962.

A gas-cooled, graphite-moderated reactor is designed with the charge pans arranged to be free from misalignment with the fuel and control rod channels due to core dimension changes. The charge pans are supported independently of the core; they may be supported by control rod guide tubes or coolant sampling pipes extending through the wall of the pressure vessel. (D.L.C.)

35103 SHIELDING ARRANGEMENT FOR NUCLEAR REACTORS. (to Licentia Patent-Verwaltungs GmbH).

British Patent 966,144. Aug. 6, 1964. Priority date Nov. 24, 1959, Germany.

A reactor shielding arrangement is described which reduces the amount of radioactivity induced in the air between the biological shield and the pressure vessel. In this arrangement, the other surface of the pressure vessel and the inner surface of the biological shield are covered with a layer of neutron-absorbing material such as B, Cd, Gd, or alloys or compounds of these elements. Air in the space between the biological shield and the pressure vessel is withdrawn and discharged into the atmosphere, and a negative pressure in the space and a cooling of the pressure vessel are obtained. (D.L.C.)

35104 THERMAL BARRIER FOR NUCLEAR REACTOR VESSEL. Pierre Bourgade (to Societe Indatom). British Patent 966,665. Aug. 12, 1964. Priority date May 30, 1962, France.

In some gas-cooled reactors, a prestressed concrete vessel and a leak-tight lining steel membrane inside the vessel are used as a pressure vessel. The concrete vessel must be thermally insulated, and a barrier is designed for carrying out the insulation. The barrier comprises against the internal face of the membrane a nest of cooling tubes housed between two corrugated sheets. The two sheets are of unequal thickness, with the internal sheet being the thinner. The thin internal sheet reduces the heat flux from the gas to the cooling fluid in the tubes. The free space between the sheets may be filled with steel wool, glass, or other insulation. (D.L.C.)

35105 FAST REACTOR CORE. Walter B. Loewenstein (to U. S. Atomic Energy Commission). U. S. Patent 3,140,234. July 7, 1964.

A light-metal-cooled fast reactor core is described, comprising a plurality of subcritical, slab-shaped fuel regions containing plutonium-239 loosely coupled by slab-shaped blanket zones containing depleted uranium. The total volume of the fuel regions is about 800 l. (AEC)

35106 CHARGING AND SERVICE MACHINE FOR GAS-COOLED REACTORS. A. P. Fraas and J. J. Tudor (to U. S. Atomic Energy Commission). U. S. Patent 3,140,238. July 7, 1964.

A charging and servicing machine for a gas-cooled reactor is described. A single externally positioned ram member is adapted to interchangeably use a plurality of ram heads to perform service and charging functions upon the reactor core structure. (AEC)

35107 PLUG FOR AN ATOMIC REACTOR CHANNEL. Didier Costes (to Commissariat à l'Energie Atomique). U. S. Patent 3,140,730. July 14, 1964. Priority date Aug. 16, 1961, France.

A plug for a pressurized reactor fuel channel is described that allows loading and unloading with complete remote control. The loading machine is necessary to effect removal of the plug because of special latches controlled by the loader conveyer element. (R.E.U.)

35108 APPARATUS FOR CONTROLLING THE ACTIVITY OF A REACTOR. Andre Huet. U. S. Patent 3,140,981. July 14, 1964. Priority date Sept. 26, 1957, France.

A control system for mobile reactors, e.g., marine reactors, is described that feature complete containment in the reactor vessel. Strips of neutron-absorber (cadmium) are distributed in the reactor side by side and may be pivoted to a position where their axes are normal to the axes of the fuel rods where no control service is performed, and conversely in other positions varying amounts of control may be made available. The strips are so arranged that their complete removal from the reactor shell is unnecessary. (R.E.U.)

35109 THERMAL REACTORS. Geoffrey Herbert Haines and Peter John Grant (to General Electric Co. Ltd.). U. S. Patent 3,140,982. July 14, 1964. Priority date Sept. 27, 1956, Great Britain.

A shield structure is described for protecting the pressure vessel of a gas-cooled reactor from severe thermal stresses due to the combined action of impinging gas streams and neutron beams. The shield is located above the vertical fuel-coolant channels and contains a neutron absorbing material such as boron. The shield is cooled by the reactor coolant. (R.E.U.)

35110 DRIVE MECHANISM. A. M. Harris and E. Ledin (to U. S. Atomic Energy Commission). U. S. Patent 3,141,380. July 21, 1964.

A control rod drive mechanism is described that is operated by fluid pressure and has a deceleration device which retards the rate of movement of the control rod into the reactor during the final portion of the rod's travel. (AEC)

Criticality Studies

35111 (HW-81211) RECENT PRTR KINETICS TESTS USING RANDOM SIGNALS. C. D. Swanson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 5, 1964. Contract AT(45-1)-1350. 8p.

PRTR moderator-level fluctuations are used as a test signal for obtaining reactor transfer function and kinetics data. Although the tests described do not produce accurate kinetics (β/l) information, they point to possibilities for further testing. The normal operating conditions affecting the moderator level excite the system in such a way that the frequency spectra of the resulting level fluctuations have significant energy content from 0.1 cycles per second, or less, to greater than 10 cycles per second. Simultaneous measurement of the fluctuations in level and the resultant fluctuations in neutron flux provide data that can be interpreted in terms of the reactor transfer function. The frequency range of the moderator level spectra is sufficient to cover the region of interest in transfer function measurements on the PRTR. Careful attention to measurement techniques and longer data recordings will improve the accuracy of the processed data. In addition, deliberate excitation of the moderator level fluctuations during the test could further improve accuracy. It is recommended that further tests, based on the use of moderator level as a reactivity excitation source, be planned. (auth)

35112 (RISÖ-81) A RECIPE FOR HEAVY-WATER LATTICE CALCULATIONS. O. Kalnaes, H. Neltrup, and P. L. Oelgaard (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). May 1964. 43p.

The heavy-water lattice recipe used at the Research Establishment Risö is outlined. It is based on the four-factor formula, the two-group theory, and the Westcott cross section concept. By means of the recipe, D_2O-moderated lattice, cooled with either D_2O, gas, or organic coolants and fueled with natural or slightly enriched uranium in the form of U-metal, UC, or UO_2, can be calculated. The fuel element must take the shape of a cluster or a single rod. From information on lattice-cell geometry, materials and physical temperatures, η, ϵ, p, f, τ, L^2, D_1, D_2, and B_m^2 are obtained. Results of the recipe are compared with measurements, and the agreement seems

to be reasonable. The recipe exists in the form of a computer programme, TATAR, written in ALGOL-60 for the Danish GIER computer. (auth)

35113 (TID-8540(p.529-609)) REACTOR-PHYSICS DATA FOR WATER-MODERATED LATTICES OF SLIGHTLY ENRICHED URANIUM. Robert L. Hellens and Glenn A. Price (Brookhaven National Lab., Upton, N. Y.).

A compilation of measurements for light-water lattices is presented. Measurement techniques, interpretation of results, and actual experimental results are described. Bucklings and critical dimensions are tabulated in the appendix. A bibliography of 109 references is presented. (R.E.U.)

35114 (ORNL-tr-263) INVESTIGATIONS ON THE EFFECT OF TWO TEMPERATURE COEFFICIENTS OF REACTIVITY, WHICH RESULT FROM SEGREGATION OF FUEL THAT WAS HOMOGENEOUS ORIGINALLY. Axel Fraude (Kernreaktor Bau- und Betriebs-Gesellschaft m.b.H. Institut für Neutronenphysik und Reaktortechnik, Karlsruhe, Germany). Translated by W. K. Ergen (Oak Ridge National Lab., Tenn.), from report INR-NR. 59/63. Oct. 25, 1963. 41p.

For a homogeneous fuel mixture of plutonia and urania there results a single negative prompt temperature coefficient of reactivity. This coefficient is composed of the weak positive contribution of the ^{239}Pu and the stronger negative contribution of the ^{238}U. If during the operation of the reactor a segregation of the two components occurs, two separate temperature coefficients are obtained. Assuming that all the heat is essentially generated in the $^{239}PuO_2$ and that the $^{238}UO_2$ is heated by conduction, there results a prompt positive and a stronger, but delayed, negative temperature coefficient. The influence of the coefficient is investigated for various reactivity perturbations. (C.E.S.)

35115 SOME ASPECTS OF ZERO POWER REACTOR TRANSFER FUNCTION. Tsutomu Nomura (Nippon Atomic Industry Group Co. Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 1: 41-50(May 1964).

Zero-power-reactor transfer functions are investigated from the viewpoint of space dependence and two-energy-group theory. The space dependence of the reactor transfer function is discussed and compared with the ordinary space-independent transfer function. Also, it is pointed out that the transfer function derived from two-energy-group theory may be used to determine subcriticality, as well as fast and thermal neutron lifetimes. (auth)

35116 PROMPT NEUTRON LIFE-TIME IN A REFLECTED SYSTEM. Hideo Kuroi, Takehiko Yasuno, Hiroshi Mitani, and Kinji Koyama (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 73-5(May 1964).

Prompt-neutron lifetimes were measured in the JAERI heavy water-moderated and -reflected, spherical, two-region critical facility fueled with enriched uranium, using the pile oscillator technique. The results were compared with calculations by the albedo methods and by bare approximation. The bare approximation proved to be quite inadequate. (D.C.W.)

35117 FAST FISSION FACTORS IN SLIGHTLY ENRICHED URANIUM, LIGHT-WATER-MODERATED SLAB LATTICES. S. Tassan (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 19: 471-4(Aug. 1964). (BNL-7663)

The ratios of ^{238}U fission to ^{235}U fission (δ_{28}) and of epicadmium to subcadmium ^{235}U fission were measured in slightly enriched $U-H_2O$ lattices with H_2O-to-U volume ratios of 4, 3, 2, 1.5, and 1:1. The fast fission factors were calculated from the δ_{28} values. The results are tabulated together with δ_{28} values calculated by the Monte Carlo method. (D.C.W.)

35118 TRANSPORT-THEORY CALCULATIONS OF TEMPERATURE COEFFICIENTS IN HETEROGENEOUS REACTOR LATTICES. John E. Suich and Henry C. Honeck (E. I. du Pont de Nemours & Co., Aiken, S. C.). Nucl. Sci. Eng., 20: 93-110(Sept. 1964). (BNL-7460)

A method is developed for calculating the temperature coefficient of ηf for heterogeneous reactor lattice cells, using only microscopic material constants as input data. The method is based on the integral transport equation and involves flux and adjoint weighting of the temperature derivatives of the kernels of the integral operators. Temperature coefficients are obtained for a localized temperature increase, as well as for a uniform increase in cell temperature. The coefficients are separated, on physical grounds, into "spectrum" and "transport" effects. The numerical accuracy of the method is found to be limited by the uncertainties in fuel reaction cross sections. The method is used in a brief survey of temperature effects in natural uranium–graphite lattices. The transport temperature coefficients are shown to yield the dependence of the thermal multiplication factor on a velocity-averaged diffusion coefficient. The spectrum temperature coefficients give the dependence of the thermal multiplication factor on average neutron velocity and disadvantage factor. Non-diffusion effects are noticed when the region near the fuel is heated. The results of the method are compared in good agreement with published experimental results for natural uranium–graphite lattices. The influence of reactor operating conditions on temperature coefficients is reproduced by the theory. (auth)

Design and Feasibility

35119 (ANL-6892) CATALOG OF NUCLEAR REACTOR CONCEPTS. PART I. HOMOGENEOUS AND QUASI-HOMOGENEOUS REACTORS. SECTION I. PARTICULATE-FUELED REACTORS. Charles E. Teeter, James A. Lecky, and John H. Martens (Argonne National Lab., Ill.). May 1964. Contract W-31-109-eng-38. 169p.

A compilation of information on nuclear reactor concepts is given. "Concept" means any actual design, proposal, plan, or idea that has been recorded in a manner suitable for study apropos to further development, and that includes all the fundamental features of a nuclear reactor proper, i.e., fuel, coolant, moderator, control means, and container. Unique configurations or modifications of standard components are considered as separate concepts. The concept descriptions are organized in chapters according to their generic relations. A dual method of presentation was adopted. Each chapter contains a narrative description of concepts described therein, highlighting their main features and resemblances and differences. Next a series of "Reactor Concept Sheets" is presented, one for each concept in a concise, standardized format, describing briefly the main features of each concept. No attempt is made to give complete engineering data. At the end of each chapter is a list of references for the concepts described as well as additional selected references. At the end of each concept sheet is a "coding" for the specific concept in terms of a coding classification system. From the codings a set of Royal McBee Keysort or IBM cards can be prepared and

used as a comprehensive cross index for selecting reactors by moderator, coolant, fuel, or any other coded characteristic. In this way the limitations due to any arbitrariness in the cataloguing may be overcome. Some degree of arbitrariness of arrangement is inevitable. Whatever method of arranging the material is chosen, some concepts might belong equally well in one chapter as another. When a concept could be included in either of two places, the more novel feature of the concept is the basis for choice. Most reactor concepts are divided into two main parts in the catalog: homogeneous and heterogeneous. A few concepts fall into a third, miscellaneous, part. The first part is divided according to the fuel, and the second part is divided according to the coolant. Purposes of reactors are identified, but the reactors are catalogued according to their core characteristics. Pebble-bed, packed- or settled-bed, fluidized-bed, fluidized- and moving-bed, paste-fuel, and particulate-fuel-element reactors are considered. (auth)

35120 PHYSICS OF HEAVY WATER LATTICES ON THE SECOND SPECIAL PANEL OF THE INTERNATIONAL ATOMIC ENERGY AGENCY. Augustin Sevcik and Vaclav Bartosek (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 10: 199-202 (June 1964). (In Czech.)

A review is given on papers presented on the state of physical investigations of heavy water lattices in various countries. Conclusions on lattice evaluation technique, calculations of lattice parameters, computer calculation technique, neutron spectra, power, temperature and void coefficients, and burn-out physics are discussed in regard to the Czechoslovakia nuclear program. (P.C.H.)

35121 SAFETY OBJECTIVES IN NUCLEAR REACTOR DESIGN. Laurance H. McEwen and Jens E. Kjemtrup (General Electric Co., San Jose, Calif.). 15p. (CONF-504-14)

From American Power Conference 26th Annual Meeting, Chicago, Apr. 1964.

Some experimental and operational observations confirming inherent and design safety features of reactors are summarized. Containment concepts and their merits are also discussed, particularly pressure suppression and a possible augmentation thereof. (D.C.W.)

35122 NUCLEAR REACTORS COOLED BY LIQUID METAL. John Webb and Owen Hayden (to United Kingdom Atomic Energy Authority). British Patent 964,841. July 22, 1964. Filed Feb. 14, 1962.

A liquid-metal-cooled reactor is designed with means for cooling the primary liquid-metal coolant in the event of failure of the primary coolant circulation system. The means comprises an auxiliary cooling coil located to promote circulation in the primary coolant by natural convection. The primary coolant circuit intake is located within the reactor tank above the core, and the auxiliary cooling coil is located at the intake. (D.L.C.)

35123 NUCLEAR REACTOR. Burton Cutts and John Malcolm Hutcheon (to United Kingdom Atomic Energy Authority). British Patent 966,409. Aug. 12, 1964. Filed Mar. 29, 1962.

A CO_2-cooled graphite-moderated reactor is designed which alleviates the moderator problems arising due to irradiation growth, reactions with coolant, fabrication, and the need for renewal. In this reactor, the graphite moderator is in granular form, and means is provided for the renewal of the moderator by granular flow. The fuel assemblies are fuel rods housed in fuel tubes of moderator material which define channels for coolant flow and provide barriers against the granular moderator. (D.L.C.)

35124 DOWNFLOW PACKED BED NUCLEAR FISSION REACTOR. L. P. Hatch and T. V. Sheehan (to U. S. Atomic Energy Commission). U. S. Patent 3,140,235. July 7, 1964.

A settled bed reactor using a liquid metal coolant is described. The fuel elements are fluidized at regular intervals to provide uniform burnup and reduce the need for excess reactivity in the core. The reactor is a fast breeder in which the fertile material is likewise in a settled bed subject to periodic fluidization. (AEC)

35125 LARGE FAST NUCLEAR REACTOR. Russell E. Peterson and Samuel L. Stewart (to U. S. Atomic Energy Commission). U. S. Patent 3,140,237. July 7, 1964.

A large reactor comprising a plurality of fissionable regions and a barrier separating each fissionable region from each adjacent fissionable region is described. The barrier comprises a moderator region and two thermal neutron absorber regions. One absorber region lies between the moderator region and one of the two adjacent fissionable regions; the other absorber region lies between the moderator region and the other of the two adjacent fissionable regions. (AEC)

Fuels

35126 (CEND-3107-216) BURNABLE POISON ADDITIONS TO UO_2. Progress Report, April 1–June 30, 1964. R. C. Brayer and W. P. Chernock (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). July 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3107. 39p. (EURAEC-1144)

Severe boron segregation was observed in vibratory compacted fuel rods containing 20/25 mesh, self-shielded B_4C particles. The higher boron concentrations found in the upper portion of the rods are the result of B_4C migration through the vibrating bed. These results contrast with those obtained with smaller (minus 325 mesh) B_4C particles. Incremental compaction is being pursued as a possible solution to this problem. A tungsten-clad UO_2–B_4C element was fabricated and will be used to verify the stability of UO_2–B_4C mixtures in a closed system at temperatures of 2100 to 2200°C. The relative potential for axial and radial boron migration is investigated by inducing UO_2–B_4C reactions in an open system containing a test element operated at a fuel centerline temperature of about 2500°C with a radial/axial thermal gradient ratio of about 250. Boron analyses are in progress. Defect clad samples were fabricated. (auth)

35127 (GEAP-3771-13) HIGH PERFORMANCE UO_2 PROGRAM. Quarterly Progress Report No. 13, April–June 1964. B. Weidenbaum (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 15, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 66p. (EURAEC-1140)

The testing of uranium dioxide fuel in the GETR Pressurized Water Loop during cycles 53, 54, and 55 is evaluated. Data and discussions are included on the routine chemistry parameters which were monitored and controlled. Fission product release data are summarized for the defects. A tentative failure mechanism is formulated that is based on the concentrating of fission product halogens locally in the upper part of the fuel rod. Successful fabrication and calibration of a rhenium-gas-bulb-trans-

ducer temperature measuring device permitted a Trail Cable Irradiation test to be made; mechanical problems and a short circuit in the electrical lead from the transducer terminated the test. An analysis is made of the possibility of using tungsten spacer disks to obviate swelling of the cladding when UO_2 melts. Uranium dioxide grain growth equation is analyzed. In fuel rod mechanism failure studies, the reaction between Zircaloy-2 and iodine is evaluated. (N.W.R.)

35128 (GEAP-4642) PROGRAM FOR THE DEVELOPMENT OF PLUTONIUM RECYCLE FOR USE IN LIGHT WATER MODERATED REACTORS. Quarterly Report No. 13, April 1–June 30, 1964. M. A. Robkin (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). July 15, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 14p. (EURAEC-1149)

The experimental determination of basic physical data, and employment of these data to establish and confirm a theoretical model for predicting the long-term changes in isotopic composition and reactivity in plutonium-enriched, light-water-moderated reactors, are reviewed. The required data are obtained from a burnup experiment in which a portion of a uranium–plutonium fuel lattice, typical of light-water-moderated reactors, is irradiated up to 5000 Mwd/t burnup in the Vallecitos Boiling Water Reactor. The technique of resonance activation is used to provide, at several locations within the fuel element, experimental verification of the calculated slow neutron spectrum. Changes in isotopic composition as a function of fuel burnup are determined by mass spectroscopic assay of fuel samples extracted at appropriate irradiation times. Fuel pins irradiated to 1860, 3000, and 5300 Mwd/t were sampled. The samples have been dissolved and aliquots prepared for mass spectrometry and burnup determination. The first Stanford Pool Irradiation indicated that there was some inconsistency in the thermal flux and the near-thermal epithermal flux. The experiment was repeated, increasing the number of foil wheel positions from two to three. The EPITHERMOS code modification was completed. Comparisons between the results computed by the code and experimental data show agreement. Metallographic photomicrographs of a polished half-pellet from a rod irradiated to 5000 Mwd/t, show structure very similar to that shown by a pellet from a rod irradiated to 1860 Mwd/t. (auth)

35129 (HW-80291) MULTICOMPONENT TUBULAR UO_2 FUEL ELEMENT IRRADIATIONS. M. K. Millhollen, G. R. Horn, and W. J. Flaherty (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1963. Contract AT(45-1)-1350. 20p.

Three multicomponent tubular UO_2 fuel element irradiation tests were conducted. Long, large diameter, tubular elements which contained particle fuel operated satisfactorily in-reactor at typical power reactor heat ratings. Defects in the cladding of fuel tubes were no more troublesome than those in small fuel rods; no significant tube distortion or fuel washout occurred. The Mark II-C, nested tubular fuel element operated more satisfactorily, with respect to wear corrosion, than 19-rod bundles in the Plutonium Recycle Test Reactor. More testing is needed to realize the full potential, both economic and operational, of tubular fuel elements. (auth)

35130 (EURAEC-992) PLUTONIUM RECYCLING. Quarterly Report No. 13, October 1–December 31, 1963. (France. Commissariat à l'Énergie Atomique, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 037-60-12RDF. 9p. (A translation).

The production of plutonium- and uranium-bearing reactor fuel elements is discussed. (N.W.R.)

35131 FISSION DISTRIBUTION IN SEVEN-PIN CLUSTER FUEL ELEMENTS. R. Gordon (Univ. of California, Berkeley), V. E. Schrock, R. N. Stuart, and A. J. Kirschbaum. Nucl. Sci. Eng., 17: 537-46(Dec. 1963). (UCRL-7007 Rev.)

An implicit solution of the integral form of the Boltzmann equation indicates that, for a given neutron spectrum, the distribution of fissions within one fuel pin of a cluster is primarily a function of three dimensionless parameters: (1) pin radius/neutron mean free path in pin material; (2) pin circle radius/pin radius; and (3) pin radius/fuel element radius. The actual distribution was determined experimentally by detector foils and autoradiographic techniques for various seven-pin, cluster type, gas-cooled fuel elements. Seven pins, assembled into a fuel element, were irradiated in the thermal column of a research reactor. It was found that the fission distribution within the center pin of the cluster was symmetrical and could be represented by $D = D_1 \exp [C_1(x^2 + y^2)]$. The fission distribution in the outer pins of the cluster was asymmetrical with respect to the pin center but could be represented by $D = D_2 \exp \{C_2[(x^2/g^2)] + (y - y_0)^2]\}$. Values of the constants in the above equations are correlated by the first two dimensionless parameters but appear to be independent of the third. (auth)

35132 IMPROVEMENTS RELATING TO NUCLEAR REACTOR FUEL ASSEMBLIES. John Michael Laithwaite and Eric Watson (to United Kingdom Atomic Energy Authority). British Patent 963,827. July 15, 1964. Filed Jan. 8, 1962.

A fuel assembly of the plate type is designed for a liquid-metal-cooled fast reactor. The fuel assembly comprises an elongated tubular casing, fuel plates extending axially within the casing, the unfuelled corrugated sheet-metal spacers interleaved between the fuel plates. The compressed state of the corrugated spacers makes for a tight fit of the fuel plates in the casing. (D.L.C.)

35133 IMPROVEMENTS IN AND RELATING TO A FUEL ELEMENT FOR NUCLEAR REACTORS. Paul Delpeyroux, Guy Lestiboudois, Claude Ringot, Alain Rulleau, and Jacques Andre Stohr (to Commissariat à l'Energie Atomique). British Patent 963,877. July 15, 1964. Priority date June 22, 1962, France.

A fuel element consisting of a rod of fissile material contained in a can is designed to inhibit ratchet distortions of the can due to heat cycling. The rod has at least two grooves formed in different directions on its side surface, and the can is pressed against the rod so that it deforms to engage the grooves and has a corrugated exterior surface. (D.L.C.)

35134 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENT ASSEMBLIES AND NUCLEAR REACTORS INCLUDING SUCH ASSEMBLIES. John David Dell (to Babcock & Wilcox Ltd.). British Patent 965,961. Aug. 6, 1964. Filed Mar. 28, 1960.

A fuel element assembly is designed for gas-cooled reactors. The assembly comprises a graphite sleeve formed from sleeve sections and within the sleeve a cluster of fuel rods. The sleeve sections have spigot-socket joints and are locked together by a grid structure which also supports the fuel rods. The use of a single unit to interlock the sleeve sections and to support the fuel rods

results in neutron economy and minimum resistance to coolant flow. (D.L.C.)

35135 NUCLEAR REACTOR FUEL ELEMENTS. Peter Waine (to United Kingdom Atomic Energy Authority). U. S. Patent 3,140,983. July 14, 1964. Priority date July 12, 1960, Great Britain.

A fuel element is described comprising a sheath tube and close-packed solid cylindrical pellets in end contact. The fuel pellets have, at their ends, central depressions one-thousandth of the pellet length in depth and 50 to 80% of the pellet diameter in diameter. The fuel element includes a stack of 47 cylindrical UO_2 pellets in a stainless steel sheath. The fuel element can be used in high-temperature environments with no straining of the sheath. (R.E.U.)

35136 FUEL ELEMENT. Peter Fortescue, Lloyd R. Zumwalt, and David C. Morse (to U. S. Atomic Energy Commission). U. S. Patent 3,141,829. July 21, 1964.

A fuel element with means for attenuating the migration of fission products is described, which comprises two concentric containers of low permeability graphite with a number of purge channels between the walls of the containers and with the inner container enclosing fuel compacts and a fission product trap. Primary coolant gas enters through a gas porous inlet in the containers and passes through the fuel element, around the compacts, through the fission product trap and out the bottom of the fuel element to the exterior of the reactor. (AEC)

35137 NUCLEAR FUEL ELEMENTS AND MANUFACTURING METHOD. Harold H. Klepfer and Millard E. Snyder (General Electric Co.). U. S. Patent 3,141,830. July 21, 1964. Filed May 9, 1960.

A fuel element which is free of cladding (Nb, Zr, or Y base) defects due to gases is described, together with a method for manufacture of metallic clad fuel elements that eliminates clad notching difficulties. (D.C.W.)

35138 NUCLEAR FUELS. Jacques Henri Dressler and Stephane Joseph Dufaure de Lajarte (to Compagnie de Saint-Gobain). U. S. Patent 3,141,852. July 21, 1964. Priority date Nov. 18, 1957, France.

A method is described for producing glass-covered beads incorporating fertile or fissile materials for use in liquid suspension as homogeneous reactor fuel. (D.C.W.)

Power and Power-Breeder Reactors

Refer also to abstracts 33753 and 34017.

35139 (APDA-NTS-1) INITIAL LOADING TO CRITICALITY OF THE ENRICO FERMI REACTOR. R. E. Mueller, C. E. Branyan, and J. B. Nims (Atomic Power Development Associates, Inc., Detroit). May 1964. 53p.

The loading of fuel into the Enrico Fermi reactor began on July 24, 1963. Criticality was achieved at 12:23 p.m. on August 23, 1963, when the reactor diverged on a 178-second period with 99 fuel subassemblies loaded. The entire loading sequence proceeded with remarkable smoothness. No spurious scrams occurred and the only delay in the schedule was a minor one brought about by maintenance on the transfer rotor mechanism. Near the end of the loading sequence, subcritical measurements were made to detect whether any significant reactivity effects existed due to primary sodium coolant flow. No flow effects were observed. After the critical loading was achieved, further measurements were made to obtain preliminary reactivity worths of the regulating control rod, the temporary in-core instrument thimble, an edge fuel assembly, and several inner radial blanket subassemblies. The last of these measurements was completed on September 3, 1963. All measurements were in good agreement with the predicted values. (auth)

35140 (CVNA-207) SUPPLEMENTARY OPERATING REPORT, APRIL 1, 1964–JUNE 15, 1964. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). 83p.

During most of April, the reactor was not operated due to maintenance and leak testing of the vapor container. The remainder of the period saw fairly steady operation at licensed power of 44.3 Mw(t). A comparison of the important plant parameters, showing design values and values determined by plant tests, is given. Most of the problems encountered were associated with what is considered to be conventional plant equipment, and these were corrected by orthodox treatment. Maintenance of the plant followed routine levels with only a few design modifications and no major time consuming problems. Radiation levels were increased with steady power operation, but in every case were well below design levels and no significant contribution to the environment. (auth)

35141 (CVNA-208) CVTR VAPOR CONTAINER LEAK RATE TEST. C. C. Wagoner and L. E. Smith (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). Apr. 1964. 24p.

Since continuous leak rate tests at 2 psig overpressure indicated leakages >0.1% per day, further tests were performed at 13 psig for 5 days and at 6 psig for 4 days. The results show that most of the leakage is due to air passing into the Instrument Air Discharge Header, and since the discharge from this header is shut off in event of a reactor accident, it cannot be considered as a leak. The leak rate also is less than that permitted by the technical specifications. (D.L.C.)

35142 (DLCS-5000564) MONTHLY OPERATING REPORT, MAY 1964. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 31p.

The Shippingport Atomic Power Station remained shutdown throughout May for the continuation of reactor plant modification for Core 2 operation and the overall operation covering the replacement of Core 1 with Core 2. The scheduled major overhaul of the main unit turbine was initiated. Reference water specifications were maintained in the canal water and coolant charging water. There were periods when the RWD cooling water was out of specifications, however, normal conditions were re-established by chemical additions. Refueling operations were temporarily suspended until completion of the required extraction crane modifications. Twenty-six modification construction orders were in progress. At the close of the month two were completed. (auth)

35143 (DP-915) HEAVY WATER MODERATED POWER REACTORS. Progress Report, May–June 1964. R. R. Hood, comp. (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). July 1964. Contract AT(07-2)-1. 49p.

The Heavy Water Components Test Reactor (HWCTR) was shut down most of May and June 1964 for repair of equipment. A D_2O leak in one of the steam generators was repaired, and shaft seals were replaced on the main D_2O pumps. A cladding failure occurred in an assembly of compacted UO_2 fuel tubes at extremely low exposure because of inadequate sealing of an end plug during fabrica-

tion of the tubes. A technique was developed for the calculation of multigroup one-dimensional neutron density distributions by the use of heterogeneous one-group diffusion calculations. Additional UO_2 fuel tubes for HWCTR irradiation tests were fabricated, and fabrication development was started on a set of UO_2 driver fuel tubes for the HWCTR. An engineering study of large D_2O-moderated power reactors indicated that reactors designed for liquid D_2O or organic cooling are technically feasible in capacities at least as large as 8300 Mw (thermal). (auth)

35144 (GEAP-4560) MECHANICAL, FLUID FLOW, AND HEAT TRANSFER OUT-OF-PILE TESTS ON EVESR MK I PROTOTYPE FUEL BUNDLE. E. E. Polomik, J. R. Fritz, and P. W. Ianni (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Feb. 1, 1964. Contract AT(04-3)-189. 100p.

An EVESR MKI prototype fuel bundle was fully instrumented and operated intermittently for a 5-month period. The vessel was operated up to 1000 psi with steam flows from 2000 to 26,600 lb/h, and steam inlet temperatures up to 825°F. Data was recorded for blowout, vibration, flow distribution, heat transfer, and pressure drop. The mechanical integrity of the fuel bundle, riser, and jumper system was satisfactory and considered to be of adequate design. No significant vibrations were noted during the various phases of operation. Average flow distribution in three of the nine tubes showed an average variation of 5 percent from equal distribution. The center and corner tubes were low and the side tube was high. Maximum deviation, from an equal one, measured 12 percent. Blowout of the flooded fuel bundle was accomplished with dry or significantly wet 1000 psia inlet steam, that steadied out to a minimum flow of 1250 lb/h. Blowout times were estimated at less than a minute for all flows above 1250 lb/h, and times in the vicinity of 2000 lb/hr were estimated to be in the order of 5 to 15 seconds. Once the bundle was blown out a flow of 700 lb/h was sufficient to keep the fuel passages clear. This was true even with steam estimated at 10 to 20 percent wet. Flows below 1250 lb/h caused partial blowout. Usually the A tube blew out first and the B and C tubes gradually cleared as flow was increased. Loss of flow then caused comparatively sudden flooding ranging from less than 2 to 3 seconds to several minutes for the different tubes within the bundle. Once the bundle was blown out and the flow maintained at more than 700 lb/h, not enough water accumulated—even with very wet steam—to cause sudden flooding of all tubes when flow was cut off. Sudden flooding occurred only in some tubes within the bundle, while others required times in the order of minutes to flood completely. Heat transfer across the riser steam gap was found to be 12 to 30 times that calculated for a stagnant steam annulus. These results are consistent with estimates of increased heat transfer due to wire wrapping in the annulus and steam circulation. Radial wall temperature drops, at the top and bottom of the riser, varied from 10 to 30°F. Pressure drop data and curves are presented for various segments of the fuel bundle and riser system. Total pressure drop was about 20 percent higher than estimated for saturated steam and was found to vary with the second power of the mass flow, indicating the strong effect of the expansion, contraction, and turn losses. (auth)

35145 (GEAP-4566) EVESR-NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT. Seventh Quarterly Report, December–February 1964. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Mar. 1964. Contract AT(04-3)-189. 102p.

Critical tests on EVESR with hot and cold cores, and with the steam passages flooded and unflooded, are reported. The full core loading of 32 fuel bundles is used in these tests. The installation of a fuel evaluation instrumentation system and a coolant sampling system is described. Specifications for the limits of temperature, power level, and coolant chemistry applicable to the Mark II fuel are given. The DARE program for computer analysis of EVESR fuel operating conditions is completed, and shows the relationships among the fuel clad surface temperature, the steam coolant flow rate, the reactor power level, and the superheated steam exit temperature. Other test and monitoring equipment and procedures are discussed. (T.F.H.)

35146 (GEAP-4601) SODIUM-COOLED REACTORS PROGRAM. FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 10, January–March 1964. C. E. Breizy, ed. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 1964. Contract AT(04-3)-189. 94p.

Research is reported on: development, fabrication, testing, and theoretical characterization of mixed Pu–U oxide fuels for fast, ceramic, liquid-metal-cooled reactors; analyses of excursions, dynamics, kinetics, and fuel cycles in this type of reactor; and neutron transport calculations for this type of reactor. (T.F.H.)

35147 (GEAP-4645) DEVELOPMENT PROGRAM ON THE GARIGLIANO NUCLEAR REACTOR. Quarterly Report No. 7. C. L. Howard (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 14p. (EURAEC-1134)

Detailed specifications of the computer calculational methods are being formulated. A topical report, "Physics Specifications for SENN On-Line Computer–Preliminary Report," is summarized. The computer equations are being flow-charted and coded in FORTRAN, and then checked for calculational accuracy on the Philco digital computer at APED. The work on the new tasks is being planned and initiated. (auth)

35148 (IA-891) SOME REFLECTIONS ON INITIATING A NUCLEAR POWER PROGRAMME IN SMALL COUNTRIES. S. Yiftah (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Sept. 1963. 11p. (CONF-426-3)

From IAEA Study Group Meeting on Research Reactor Utilization, Athens, Sept. 1963.

The role of research reactors in the development of nuclear power programs is discussed. Information that can be obtained from research reactors is reviewed. (R.E.U.)

35149 (NAA-SR-9509) MEASUREMENT OF THE REACTIVITY ABSORBED BY SODIUM IN THE SRE. A. L. Gunby and J. M. Kallfelz (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1964. Contract AT(11-1)-Gen-8. 23p.

The reactivity absorbed by sodium in the Sodium Reactor Experiment Core II was measured to be $7.50. Subcritical multiplication techniques were used in conjunction with a draining experiment. Subsequent calculations were sufficiently accurate to obviate the need for future draining experiments. (auth)

35150 (NYO-9789) HEAT EXCHANGERS. SURVEY OF COMPONENT REQUIREMENTS AND AVAILABILITY FOR GAS-COOLED NUCLEAR REACTOR POWER PLANTS. Georgs Novickis (Franklin Inst. Labs. for Research and Development, Philadelphia). May 1963. Contract AT(30-1)-2512. 440p. (I-A2392-4)

The state-of-the-art of heat exchangers for gas-cooled reactor primary circuits is established by describing steam generators, primary heat exchangers, recuperators, and coolers of a number of gas-cooled nuclear projects, and by listing plant and exchanger main characteristics in three summary tables. Information is based in part on references indicated and in part on data from manufacturers. The availability of suitable heat exchangers is represented in the form of 35 Data Sheets submitted by manufacturers. A list of manufacturers and their addresses is given. (auth)

35151 (ORNL-TM-564) THE EFFECT OF SCALE-UP ON FUEL CYCLE COSTS FOR ENRICHED FUEL AND NATURAL URANIUM FUEL SYSTEMS. Floyd L. Culler (Oak Ridge National Lab., Tenn.). Apr. 16, 1963. Contract [W-7405-eng-26]. 26p.

Cost differences between natural uranium and partially enriched uranium fuel cycles are discussed. The estimated costs for a 10 ton per day, single purpose fuel cycle for a reactor of the Dresden type using 1.5% enrichment (Core 1) are given. Burnup and inventory charges were calculated for advanced pressurized-water reactors. (R.E.U.)

35152 (ORNL-TM-732) MSRE DESIGN AND OPERATIONS REPORT. PART V. REACTOR SAFETY ANALYSIS REPORT. S. E. Beall, P. N. Haubenreich, R. B. Lindauer, and J. R. Tallackson (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 214p.

A detailed description of the MSRE is presented, and the hazards associated with this reactor are evaluated. (C.E.S.)

35153 (SRO-103) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, JUNE 1964. (Savannah River Operations Office, AEC). 8p.

A review is presented of the evaluation of materials for heavy-water power reactors, fabrication and testing of components (fuel elements, sheath tubes, etc.), and the operations and test programs of CANDU, HWCTR, and CVTR. (T.F.H.)

35154 (SWRI-1228-28) EVALUATION OF THE SERVICEABILITY OF THE ELK RIVER REACTOR PRESSURE VESSEL. Progress Report No. 6, April 1–May 31, 1964. José McDonald, Jr., Allen R. Whiting, and Kenneth K. Speirs (Southwest Research Inst., San Antonio). July 6, 1964. Contract AT(11-1)-1228. 27p.

The serviceability of the Elk River Power Reactor pressure vessel is to be evaluated by determining the effects of fabrication procedures, irradiation, dissimilar weld metallurgy, and geometry on the fatigue life and nil-ductility transition temperature of the completed vessel. Some test results and test instruments are described. (T.F.H.)

35155 (TID-7679(p.357-68)) NOISE SOURCES IN POWER REACTORS. Joseph A. Thie ([Argonne National Lab., Ill.]).

Detector noise, total reactor noise, common reactivity-noise sources, spatially distributed noise, input-noise filters, effects from nonwhite-noise sources, cross correlation, and inlet temperature as a noise source are considered. (R.E.U.)

35156 (TID-7679(p.427-47)) REACTOR-NOISE MEASUREMENTS ON SAXTON REACTOR. V. Rajagopal (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh).

Experimental analysis of the inherent fluctuations (noise) in a power reactor was conducted to determine applications to the characterization of dynamics of power reactors and to provide experience in applying such techniques. An analog spectrum analyzer was employed. Measurements of the power spectra and cross power spectra of the fluctuations in power, coolant flow, temperature, and counting rate during shutdown were performed at various reactor-power levels. Applications and the usefulness of noise analysis in obtaining information on the dynamic behavior of a power reactor are discussed. (auth)

35157 (TID-7679(p.449-68)) REACTOR-NOISE EXPERIMENTS ON HALDEN BOILING WATER REACTOR. Tapio Eurola (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt).

The reactor-noise measurements performed during power operation with the Halden Boiling Water Reactor first fuel charge are summarized. The scope of the noise measurements with the second fuel charge and the experimental facilities are also described. However, because these measurements were performed very recently, only a fraction of the experimental results is given, and is not given as conclusive, but rather as indications of some of the findings, which still require a more careful study. (auth)

35158 (TID-7679(p.469-500)) NOISE MEASUREMENTS IN THE DOUNREAY FAST REACTOR. F. D. Boardman (United Kingdom Atomic Energy Authority. Industrial Group. Dounreay Experimental Reactor Establishment, Caithness, Scotland).

During the high-power run in the Dounreay Fast Reactor in May 1963, recordings were made of fluctuations in power and inlet and outlet coolant temperatures. They are being analyzed by a correlation technique. The equipment used is described, and the results of the analysis to date are discussed. Analysis has shown the following: (1) The presence of a damped resonance at 6 cycles/sec in reactor-power noise, a theoretical explanation of which is given. (2) The dominant time constant in the transient response of the reactor is about 10 sec. (3) The presence of a large low-frequency component in the power spectrum of reactor noise. (4) Information on the temperature coefficient of reactivity associated with coolant flow as measured by one thermocouple above the core. It is concluded that although some useful information has been obtained a great deal more work is required before an assessment of the value of the technique can be made or the lines of future development established. (auth)

35159 (TID-8540) REACTOR TECHNOLOGY, SELECTED REVIEWS—1964. Leonard E. Link, ed. (Argonne National Lab., Ill.). 636p.

Highlights of a year's progress in reactor technology are presented for commercial power reactors cooled with gas, light water, sodium, heavy water, or organic liquids, for boiling burnout in reactor design, in-core instrumentation, cladding materials behavior in water and steam, metallic fuels, pyroprocessing of reactor fuels, reactor by-products, and physics of water-moderated enriched lattices. Separate abstracts were prepared for the 9 sections. (R.E.U.)

For abstracts of individual sections see: 33683, 33984, 34076, 34130, 35089, 35113, 35160, 35161, and 35162.

35160 (TID-8540(p.1-69)) COMMERCIAL POWER REACTORS COOLED WITH GAS OR LIGHT WATER. Stuart McLain (Argonne National Lab., Ill.).

A general discussion of gas- and light-water-cooled nuclear power reactors, both domestic and foreign, is presented. A survey is presented of reactors being designed and constructed as well as those in operation; power costs; design problems; and trends in construction. A bibliography of 122 references is presented. (R.E.U.)

35161 (TID-8540(p.71-129)) COMMERCIAL POWER REACTORS COOLED WITH SODIUM, HEAVY WATER, OR ORGANIC LIQUIDS. Chad J. Raseman and Leon Green (Brookhaven National Lab., Upton, N. Y.).

Technical progress in sodium-graphite reactors, fast reactors, heavy-water-moderated reactors, and organic-moderated reactors is reviewed. Specific reactors and reactor concepts are surveyed. A bibliography of 63 references is presented. (R.E.U.)

35162 (TID-8540(p.131-76)) BOILING "BURNOUT" FOR REACTOR DESIGN. R. P. Stein and P. A. Lottes (Argonne National Lab., Ill.).

The current status of the ability both to understand and to predict the occurrence of a critical heat-transfer condition in boiling is reported, and suggestions of methods of attacking the problem as it occurs in reactor design are made. A bibliography of 68 references is presented. The appendix contains tables and data source lists for specific experimental data available and recommendations for their use; subcooled boiling in ducts and bulk boiling in ducts are indexed according to fluid, pressure range, details of duct geometry, flow rate, and inlet and outlet subcooling or quality. (R.E.U.)

35163 (TID-20890) REACTOR SAFETY SYSTEM DESIGN ANALYSIS— EXPERIMENTAL GAS COOLED REACTOR. E. R. Gasser (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). July 20, 1960. Contract [AT(10-1)-925]. 39p. (EGCR-STUDY-II-601)

The safety system of the EGCR was analyzed to determine the basic requirements of the system components. These requirements include selection of measurable plant parameters whose deviation from preset values results in safety actions, determination of the nature of the safety actions to be taken, determination of trip points for safety-system actions, and determination of required response times of safety-system components. (C.E.S.)

35164 (TID-20891) TECHNICAL ANALYSIS BLOWER AND TEMPERATURE CONTROLLER REACTOR SAFETY SYSTEM ANALYSIS—EXPERIMENTAL GAS-COOLED REACTOR. Ralph P. Marcotte (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Apr. 7, 1960. Contract [AT(10-1)-925]. 41p. (EGCR-STUDY-II-601-1)

The analog computer model and settings of the reactor outlet temperature controller were determined for inclusion in the EGCR safety and control analysis. The analysis of the blower controller is also included. (C.E.S.)

35165 (WCAP-6063) YANKEE CORE EVALUATION PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1964. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). July 1964. Contract AT(30-1)-3017. 85p.

A summary is presented of: computational and experimental results on the isotopic compositions of spent Yankee Reactor fuels; the evaluation of Yankee control rods; and the distribution of power within the Yankee core. (T.F.H.)

35166 (ANL-Trans-38) PROJECT: MAGNETOHYDRODYNAMIC (MHD) IMPACT FLOW TUBE. REPORT NO. 1. INTRODUCTION OF THE PROJECT; PROBLEM PROPOSAL FOR THE INVESTIGATION. R. Radebold (Allgemeine Elektrizitätsgesellschaft, Frankfurt am Main). Translated by Elmar K. Wilip (Argonne National Lab., Ill.). May 13, 1963. 17p.

A direct process for the transformation of fission heat into electric energy in liquid-metal-cooled fast breeder reactors is described. The MHD impact flow tube uses the liquid metal coolant as the working fluid of the system. The MHD impact flow tube is a closed circuit that consists of a drive and a converter. The thrust of the working fluid performs work against an external force, the Lorentz force. The degree of efficiency and feasibility of the MHD process are discussed. (C.E.S.)

35167 STEEL FRAMEWORK FOR THE TOP CONCRETE SHIELD FOR REACTOR, EDF 1, AT CHINON (FRANCE). L. Galery (N. Raytchine and P. Chatelain, Paris). Acier-Stahl-Steel, 28: No. 3, 130-2(1963).

The steel framework used in casting the conctete shield slab overlying the reactor and bearing the weight of the fuel-handling equipment on its perimeter is described. Both the temporary framework used for casting the peripheral ring of the slab and the framework embedded in the central part of the slab are discussed. (D.C.W.)

35168 ON THE CALCULATION OF THERMAL REACTORS WITH PLUTONIUM RECYCLING. P. Wenzel (Ventsel) (VEB Atomkraftwerk, Berlin). At. Energ. (USSR), 16: 413-17(May 1964). (In Russian)

A survey is made of the stable regime of a reactor using natural or depleted uranium with partial recycling of the plutonium formed in the fuel cycle. The optimal probability value to avoid resonance absorption in ^{238}U and the ratio of the moderator volume to the volume of fuel and fraction of recycled plutonium are determined. The dependence of the neutron multiplication factor on these parameters is investigated, and the existence of a maximum multiplication factor is demonstrated. On the basis of the study a possibility is shown for exploiting water-moderated water-cooled or boiling reactors using natural uranium with partial use of the plutonium formed. (tr-auth)

35169 COMPARATIVE THERMODYNAMIC CYCLES AND BALANCE OF SOME NUCLEAR AND CONVENTIONAL POWER PLANTS. J. Denoyers and R. Roche (Electricite de France, Paris). Bull. Inform. A.T.E.N. (Assoc. Tech. Energie Nucl.), No. 47, 45-56(May-June 1964). (In French)

The thermodynamic cycles and thermal balance of three French nuclear power plants and one French conventional power plant (the EDF-2, EDF-3, Chooz, and Vaires-sur-Maine power plants). A general description is given of the thermodynamic cycle of a power plant, and the individual characteristics of the four power plants being compared are shown schematically. The heat extraction, recovery of energy, and transformation and yield for all four power plants are discussed. The general characteristics of the plants and their thermal balance are tabulated. (J.S.R.)

35170 SOME ECONOMIC ASPECTS OF NATURAL URANIUM NUCLEAR POWER PLANTS. M. J. Gaussens (Commissariat à l'Energie Atomique, Saclay, France). Bull. Inform. A.T.E.N. (Assoc. Tech. Energie Nucl.), No. 47, 57-69(May-June 1964). (In French)

The principal economic aspects of nuclear power plants using natural uranium as fuel and graphite as moderator are developed. The fuel economy, capital charges, and operating costs are discussed. The total kwh cost for a 500 Mwe reactor is derived. Cost factors of a natural ura-

nium reactor moderated with heavy water are considered briefly. (J.S.R.)

35171 A PANORAMA OF NUCLEAR CANADA. Can. Nucl. Technol., 3: 27-34(Summer 1964).

The status of nuclear power and radioisotope research and technology in Canada is reviewed. The NRU and NRX reactors are described, along with the CANDU concept developed from them. Results from experience with the NPD reactor are discussed. Research programs, developments in applied isotopes, industrial irradiation plants, virus inactivation by irradiation, radioinduced graft polymerization, applications of tracers, and development of irradiation chambers are described. (M.C.G.)

35172 CANDU POWER COSTS COMPETITIVE WITH BWR. G. A. Pon (Atomic Energy of Canada Ltd., Chalk River, Ont.) and R. L. Beck. Can. Nucl. Technol., 3: 45-8(Summer 1964).

An economic comparison indicated that there is approximately 0.7 mill/kwh difference in unit energy cost between Oyster Creek and Nine Mile Point BWR's when their published energy cost estimates are modified for Canadian conditions. The estimated energy cost for CANDU-type stations was equal to that of the lowest cost BWR (Oyster Creek). If the energy cost from future BWR's falls between that of Oyster Creek and Nine Mile Point, then the CANDU-type reactor would be considered superior for Canadian conditions. (auth)

35173 FUTURE TARGETS FOR CANADIAN POWER REACTORS. A. J. Mooradian (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Nucl. Technol., 3: 49-53 (Summer 1964).

Requirements of established reactors for further development are discussed. Topics covered include: fuel bundle developments, industrial participation, instrumentation and zonal control, and development of an inexpensive flux detector. Factors to be considered in the definition of future targets are outlined. The technical status of the following reactor concepts is presented: boiling D_2O with UO_2 fuel (indirect cycle), boiling H_2O with natural UO_2 fuel (direct cycle), and organic-cooled reactors. Determining where to concentrate effort and evolutionary stages are discussed. (M.C.G.)

35174 ECONOMICS OF U. S. WATER REACTORS: A LESSON FOR THE BRITISH NUCLEAR INDUSTRY? Elec. Rev., 174: 627-9(Apr. 24, 1964).

The capital costs of U. S. plants, particularly the factors contributing to cost reductions, are discussed; and the prospects for achieving equally favorable costs in Britain are briefly considered. (D.C.W.)

35175 YANKEE. AN OPERATING HISTORY. R. J. Coe (Yankee Atomic Electric Co., Boston), R. J. Creagan, and J. N. Kilpatrick. Energie Nucl., 6: 142-9(May 1964). (In French)

An account is given of the results obtained since the beginning of the operation of the Yankee Reactor at power with core I and then with core II. The evaluation for performance of the parts of the reactor and the auxiliary installations, the operating accounts, the results of the tests carried out (mechanical and chemical) are satisfactory and promising from the technical and economic points of view. (P.C.H.)

35176 THE IMPACT OF GRAPHITE FUEL DEVELOPMENT ON HIGH-TEMPERATURE STEAM GENERATION. R. A. Meyer and C. L. Rickard (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Energie Nucl., 6: 159-70(May 1964). (In French)

The development of fuel elements that could operate at high surface temperature and then permit the utilization of more efficient steam cycles, should lead to a reduced cost of manufacture per kilowatt-hour thanks to a fuel economy and high burnups. The goal of satisfying such requirements has led to the design of a high temperature graphite fuel element (HTGR), which is described; graphite is used at the same time as moderator, fuel can and matrix, and structural material. Out-of-pile and in-pile tests where conducted on both fuel compacts and graphite sleeves. Applications of the fuel element will be made in 40, 500, and 1000 Mw(e) nuclear plants. (auth)

35177 HUNTERSTON NUCLEAR GENERATING STATION. SOME COMMENTS ON ITS DESIGN, CONSTRUCTION AND COMMISSIONING. R. G. Sherwen. G.E.C. J. Sci. Tech., 31: 59-68(1964).

The difficulties encountered as well as the successes achieved in the design, construction, and commissioning of the Hunterston Nuclear Generating Station are discussed. The first reactor has given indication of an output potential substantially in excess of design feature; the second reactor is expected to reach its full rated output by July, 1964. Illustrations and technical data are presented. (L.B.S.)

35178 NUCLEAR POWER TODAY AND TOMORROW. Frank Schwoerer, Jr. and Warren F. Witzig. IEEE (Inst. Elec. Electron. Engrs.), Spectrum, 1: 120-30(July 1964).

The firmly established applications of nuclear power such as electric power generation, submarine propulsion, and space auxiliary power are reviewed. Several new areas of application including booster rockets for deep space, desalting of sea water, power packages for hardened sites, and underground explosions of nuclear devices are also discussed. (C.E.S.)

35179 CALCULATION OF FUEL CYCLES OF GAS-COOLED POWER STATIONS MADE ON DIGITAL COMPUTER. Karel Januska (Research Inst. of Power Engineering, Prague). Jaderna Energie, 10: 191-6(June 1964). (In Czech.)

Research on optimization calculations of heavy water and gas-cooled nuclear power stations are summarized. A comparison was made of various types of secondary cycles from the point of view of thermal efficiency. (P.C.H.)

35180 ATOMIC POWER. I. CENTRAL POWER STATIONS. C. E. Wise. Machine Design, 36: 116-23(Apr. 1964).

The reactor types presently used or under development for commercial power production are briefly reviewed; and the safety of reactors is discussed, including design and inherent safety features. The economics of nuclear power and the future of breeder and burner reactors are also briefly considered. (D.C.W.)

35181 WASTE GAS HANDLING. SYSTEM FOR 300 Mw DIRECT CYCLE BWR. E. E. Duke (Aerojet-General Corp., Azusa, Calif.). Nucl. Eng., 9: 245-8(July 1964).

The results of an analysis of gas release in a 300-Mw (thermal), direct-cycle boiling water reactor are presented. Available processing methods and gaseous waste disposal requirements are summarized, and two absorption systems are proposed for reducing the effluent gases to less than 0.1 the maximum permissible concentration taken as 10^{-10} $\mu C/cm^3$ in the stack. (D.C.W.)

35182 MAXIMUM COMPONENT TEMPERATURES IN GAS-COOLED MAGNOX REACTOR FUEL CHANNELS. R. V. Greenland. S. African Mech. Engr., 13: No. 3, 61-7 (Oct. 1963).

The general equations governing the heat transfer and temperature distribution in Magnox reactor fuel channels are set up. Assumptions and simplifications are made in order to obtain analytical solutions to these equations so as to determine the axial positions in the channels and the magnitudes, of the maximum temperatures, both of fuel and the surrounding sheath. Refinements to the solution are included to account for the discontinuous nature of the axial heat generation and the variation in reactor material properties. Comparison of the results obtained with those given by an exact step-by-step numerical method shows good agreement when applied to conditions encountered in a typical commercial Magnox reactor fuel channel. (auth)

35183 KARACHI NUCLEAR POWER PROJECT. M. S. Qaadri. Trade Ind., 8: 514-15; 517(Apr. 1964).

The power demands and resources of the Karachi area are summarized; and the Canadian-designed, heavy water moderated and cooled, natural uranium fueled, horizontal pressure tube reactor to be used in the 132-Mw Karachi power station is discussed. Capital and energy costs for the 132-Mw nuclear plant are compared with those for a gas-fired station. (D.C.W.)

35184 EFFECTS OF STEAM PRESSURE ON POWER REACTOR ECONOMICS. A. R. Jones and R. C. Bauman (Westinghouse Electric Corp., Pittsburgh). 17p. (CONF-504-12)

From American Power Conference 26th Annual Meeting, Chicago, Apr. 1964.

The steam cycle presently used for closed-cycle water reactors is described, and the effects of steam pressure on reactor economics are discussed using the results of a study for a 375-Mwe plant. (D.C.W.)

35185 WATER CHEMISTRY AT DRESDEN NUCLEAR POWER STATION. Warren I. Kiedaisch (Commonwealth Edison Co., Morris, Ill.). 9p. (CONF-179-11)

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

The chemical problems of a boiling water nuclear power plant of the Dresden type and their similarities to those of a conventional fossil-fired plant are discussed. Radiation levels are an invisible barrier to most direct observations. Different techniques must be learned for these inspections and instruments depended on more to do the job. No serious problems or equipment failures occurred that are attributable to chemistry. Several areas where additional study is necessary are listed. (auth)

35186 CHEMISTRY HIGHLIGHTS OF A BOILING WATER REACTOR. C. J. Hartman (Big Rock Point Nuclear Plant, Charlevoix, Mich.). 10p. (CONF-179-6)

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

Some typical analytical and radiochemical results for the Big Rock Point BWR are presented. Reactor water pH is discussed for various operating conditions. (R.E.U.)

35187 NUCLEAR FUEL SCHEDULING FOR THE MALIBU NUCLEAR PLANT UTILIZING THE IBM 1620. L. J. Weidner, Jr., Robert C. Burt, and Raymond C. Burt (Dept. of Water and Power, Los Angeles). 39p. (CONF-529-2)

From AIPE-ASME Maintenance and Plant Engineering Conference, Los Angeles, Apr. 1964.

Fuel scheduling using the IBM 1620 with the critical path method is discussed. The computer program is outlined, a sample listing of a fuel schedule is included. (D.C.W.)

35188 HIGH-PRESSURE STEAM POWER CYCLES AND SUPERHEAT STEAM CYCLES OF REACTORS. Henry D. Schoenwetter (Burns and Roe, Inc., New York). 18p. (CONF-504-11)

From American Power Conference 26th Annual Meeting, Chicago, Apr. 1964.

The economics and thermodynamics of higher steam pressures and temperatures were investigated, using a power plant with a gross generator output of 539,600 kw as the reference design. Superheat steam temperatures on the order of 250°F are economically justified at all fixed charge rates. The practicability of temperatures on the order of 450°F depends on fuel cladding considerations. Pressure increases up to 2000 psi provide an increasing economic advantage at all fixed charge rates. (D.C.W.)

35189 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 963,565. July 15, 1964. Priority date Dec. 4, 1961, United States.

An improved reactor core assembly is designed for high-temperature gas-cooled reactors. The core assembly gives improved stability and durability of the core components while permitting expansion of these components, permits semi-continuous refueling during operation, and results in more effective containment of fission products. Parameters of 80- and 20-Mw(e) reactors using the improved core assembly are given. (D.L.C.)

35190 METHOD OF OPERATING A PRESSURE WATER-COOLED ATOMIC REACTOR. Olaf Harald Vilhelm Lange (to Aktiebolaget Atomenergi). British Patent 966,182. Aug. 6, 1964. Priority date Aug. 2, 1962, Sweden.

A method for the operation of a pressurized-water reactor is given which generates steam without the use of a heat exchanger. In this method, water is withdrawn from the reactor at high pressure and temperature, the water pressure is decreased, the velocity of the steam–water mixture is increased by the steam generation, the steam is separated from the water by centrifugal force, the kinetic energy of the separated water is converted into pressure head, and the water is then returned to the reactor. Under the right conditions, a self-sustaining flow of water is set up. (D.L.C.)

35191 IMPROVEMENTS IN NUCLEAR POWER PLANT. Thomas Deighton (to Babcock & Wilcox Ltd.). British Patent 966,743. Aug. 12, 1964. Filed Jan. 15, 1960.

A nuclear power plant with a pressurized-water reactor, is described in which the motor of the coolant circulation pump is cooled by an auxiliary circuit. This auxiliary circuit includes an ion exchange column for ensuring that the pump motor coolant is of the same purity as the primary coolant, since it communicates with the pump interior through a labyrinth gland. (D.L.C.)

35192 BREEDER REACTOR CORE WITH ALTERNATE ZONES OF DEPLETED AND ENRICHED FUEL. Haig P. Iskenderian (to U. S. Atomic Energy Commission). U. S. Patent 3,141,827. July 21, 1964.

A reactor core is described that comprises a central zone of slightly enriched fuel, a number of alternate concentric zones of depleted fuel and zones of slightly enriched fuel surrounding the central zone, and movable control rods disposed in the core in a regular pattern in which the central zone is square in cross section, the depleted zones are

generally square in cross section, and the fuel elements forming the depleted zones are quadrangular in cross section and are surrounded on at least three sides by fuel elements from the slightly enriched zones. (AEC)

Production Reactors

35193 (HW-78431) CONCENTRATION OF CORROSION ISOTOPES IN HALF-PLANT LOW ALUM FEED WATER TREATMENT AT F REACTOR. C. W. Thomas and W. B. Silker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 29, 1963. Contract AT(45-1)-1350. 7p.

A half-reactor test was conducted to measure any difference in corrosion caused by different concentrations of alum flocculant in the cooling water treatment process. The coolant for the control side had been treated with 18 ppm alum feed, while the test side used 23 to 6 ppm. ^{24}Na, ^{72}Ga, and ^{65}Ni concentrations in both risers were determined periodically during the test. The results indicate that the corrosion and/or erosion of the Al reactor tubes and fuel element jackets is not significantly altered by high or low alum feeds. (D.L.C.)

35194 (HW-78964) CONCENTRATION OF CORROSION ISOTOPES IN HALF-PLANT LOW pH COOLANT AT D REACTOR. C. W. Thomas and W. B. Silker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 3, 1963. Contract AT(45-1)-1350. 10p.

Reducing the pH of the coolant water from 7.0 to 6.6 reduced the thickness of the corrosion film on the aluminum reactor tubes and fuel jackets and was reflected by comparing the ^{24}Na concentration of the two riser samples. ^{72}Ga comparisons indicated an immediate reduction in surface film dissolution and/or erosion with pH 6.6 coolant. ^{65}Ni ratios indicated a major reduction of fuel jacket corrosion with pH 6.6 coolant. (auth)

35195 (HW-82233) NPR STEAM GENERATOR TUBING BURST TESTS. P. M. Jackson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 8, 1964. Contract AT(45-1)-1350. 13p.

Following installation of steam generators, pressure testing was conducted to insure the integrity of the piping system, and it was found that the steam generator tubing bundles in several of the units had appreciable leakage. Many tubing sections were removed from the tube bundles for destructive evaluation and testing, including rupture and burst tests. The limited test program that was undertaken has shown that operational failures which could occur will not be of the catastrophic type. All of the failures in this material experienced at 3000 psi or less internal pressure were of the pinhole or small crack type, which allowed only a very small leakage rate to occur and produced only localized tube deformation. General test conditions chosen were 300°C at pressures of 3000, 4500, and 6000 pounds per square inch for the stress rupture testing. Burst testing, of course, necessitated elevating the pressure to the ultimate value for the particular test piece being investigated. In tube sections containing many defective areas, penetrating approximately 75% of the tube wall, the nondestructive test sometimes, but not always, selected the area that would fail in the destructive test. (auth)

35196 THE PRESTRESSED CONCRETE CONTAINER OF G2 AND G3. Jean Bellier and Max Tourasse. Bull. Inform. A.T.E.N. (Assoc. Tech. Energie Nucl.), No. 47, 31-44(May-June 1964). (In French)

The prestressed concrete pressure vessels of the G2 and G3 reactors are described. The prestressing method used is indicated, and the particular problems of curves is discussed. The construction of the containers is then described. (J.S.R.)

Propulsion and Space

Refer also to abstracts 33754 and 35178.

35197 (64SD700) RESEARCH ON SPACECRAFT AND POWERPLANT INTEGRATION PROBLEMS. Third and Fourth Quarterly Report, October 26, 1963–April 26, 1964. John W. Larson (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Contract NAS 3-2533. 216p.

The major effort is directed toward the 1 Mw Rankine cycle powered spacecraft. However, a 4 Mw Rankine cycle and a 1 Mw thermionic cycle powered spacecraft are studied, and these results are presented. The 1 Mw thermionic vehicle uses a fixed conical-cylindrical radiator. The primary radiator heat rejection temperature was selected at 1800°F for studying and comparing to lower temperature beryllium radiators. The potential radiator materials were compared and L605 (Haynes 25 alloy) was selected for use in the spacecraft design layout. Beryllium was assumed for the low temperature secondary radiators. The resultant powerplant specific weight was estimated at 27 lb/kw(e), exclusive of shield. A layout of a turboelectric powered vehicle using four of the 1 Mw(e) electrical generation system modules was completed. In addition, structural design and analysis were performed. More detailed analyses of the 1 Mw(e) spacecraft were completed. To ascertain the significance of thermal stresses in the primary and secondary radiators, a stress and relaxation analysis was performed. An investigation of aerodynamic and inertia loads was completed. The launch environment dynamic analysis was revised from the previous four degree of freedom system to a seven degree of freedom system, with three possible levels of damping, to determine vibration levels. The feed lines were added to the radiator optimization program and as a result, the liquid metal inventory was significantly reduced, although at only a slight net weight reduction. As a result of a more detailed estimate of radiator circuit pumping power and power conditioning equipment losses, the net useful power was increased from 1.0 to 1.2 Mw(e), yielding a 20% reduction in powerplant specific weight. A 3 lb/kw(e) specific weight reduction was also achieved by locating the transformers at the turboalternator, thereby eliminating the low voltage level electrical transmission lines. A study of radiator parameters was conducted to determine the influence of power level, area restrictions, meteoroid flux, radiator survival probability, redundancy and radiator fluid selection on powerplant specific weight. The advantage of lithium over NaK as a radiator fluid was estimated at about 1.2 lb/kw(e) reduction in powerplant specific weight. The electrical system configurations for the 1 Mw(e) turboelectric and thermionic system were improved and electrical and thermal cooling loads distribution profiles defined. A multiple turbogenerator schematic was prepared. System interactions were studied with specific reference to power factor, harmonic distortion, radio noise, and fault current and torques. Parametric studies of transformers and transmission lines, showing skin effect, were completed. To aid in comparisons of single versus multiple turbogenerators, design studies of 300 and 600 kw units were undertaken. Mechanical, aerothermodynamic, and electromagnetic designs were prepared for the turbine

and generator using a two bearing rotor assembly with an axial gap inductor. It was found to be possible to overhang the inductor at these powers, thereby requiring a single dynamic seal. Turbine and generator design limit curves were prepared. Bearing sizing and losses, rotor vibration considerations, and generator electromagnetic loading coefficients were studied. In addition, an alternate boiler design was prepared using "L" shaped tubes and a four turbogenerator integrated power package layout was generated. The effect of in-flight reduction of power on mission success was investigated and the results are rather discouraging. If this event occurs during or after the coast period, the mission trajectory cannot be altered appreciably, and the proper course of action is to reduce specific impulse to maintain the proper thrust profile. This suggests that the electric propulsion system should have a capability for variable specific impulse. (auth)

35198 (NAA-SR-8617(Vol.I)) SNAP TECHNOLOGY HANDBOOK. VOLUME I. LIQUID METALS. G. F. Burdi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 1, 1964. Contract AT-11-1-GEN-8. 155p.

Physical and chemical properties, heat and material transfer, and hydraulic aspects of Hg, Na, NaK, K, Ru, and Li are given. A bibliography of 126 references is included. (R.E.U.)

35199 (NAA-SR-9054) SNAP 2 STRUCTURAL AND DYNAMIC ANALYSIS. R. A. Castle (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 1, 1964. Contract AT(11-1)-Gen-8. 125p.

The structural design criteria and the system basic loads for the SNAP 2 compact power unit are presented. Included in these structural criteria are the following environments: ground, prelaunch, launch, preorbital-startup, and orbital startup and continuous operation. These data were then used to determine the structural integrity of the system and to satisfy the reliability requirements. A summary is presented of the more significant system structural and dynamic analyses generated on the SNAP 2 compact power unit. (auth)

35200 (NAA-SR-9280) THERMAL TESTING OF THE SNAP 10A PROTOTYPE SYSTEM (PSM-3). W. F. Marten and J. H. Van Osdol (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1964. Contract AT(11-1)-Gen-8. 109p.

The test vehicle and facilities for the SNAP 10A PSM-3 non-nuclear test vehicle are described. Tests and their objectives, and test results are discussed. System design points included in the test results are: heat input to converter, heat rejected by radiation, heat radiated by the NaK lines to the radiator, heat transfer through TE elements, electrical power, efficiency, and heat barrier heat loss. Electrical and hydraulic tests were performed. (R.E.U.)

35201 (NAA-SR-9368) SNAP REACTOR HANDBOOK—TRANSIENT ANALYSIS. W. A. Rhoades and W. B. Green (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1964. Contract AT(11-1)-Gen-8. 40p.

Some of the problems involved in the kinetics of uncontrolled power transients in SNAP reactors, and some of the techniques available for solving them are discussed. The discussion is oriented toward a basic SNAP design, as typified by a small epithermal reactor with a cylindrical core approximately 12 in. high by 8 in. in diameter, moderated by zirconium hydride fuel rods and fueled with fully enriched ^{235}U dispersed in the zirconium hydride. It has, typically, a 3-in. beryllium reflector about the radial surface, and is bare at the ends. The coolant is sodium-potassium alloy and is pumped through the interstices between the fuel rods. A review of space-independent kinetics equations for bare and reflected reactors, the more important feedback effects present in SNAP reactors, analytical solutions to the equations applicable in certain special cases, and a review of the computer codes available for solution of the equations in the general case are included. (auth)

35202 (NAA-SR-9655) SNAP-10A STRUCTURAL ANALYSIS. J. R. Boulanger (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1964. Contract AT(11-1)-Gen-8. 57p.

All stress analyses done on the SNAP 10A system are summarized and discussed; many of the structural tests which were accomplished are mentioned. A stress analysis was made on all elements of the primary structure and on all structural components. (auth)

35203 (NP-14139) THE ROLE OF NUCLEAR POWER IN THE MERCHANT MARINE. Summary Report. (Sharp (George G.) Inc., New York). Mar. 15, 1963. Contract MA-3064. 41p. (N-6022)

The position of the U. S. Merchant Marine in today's commercial and political environment is analyzed, and in general found to be deficient with respect to the needs of the United States Government, both military and non-military, and to the needs of the shipper and ship operator. There is no indication that continuation of present policy will improve the situation. The characteristics of a marine transportation system which would be responsive to the demands of the national interests are developed. This system is based on privately owned and operated high-speed nuclear-powered ships, and it is found that: (1.) The new system is a high speed system, which meets the requirements of the military in respect to short response time and ability to transport all types of military cargo. (2.) At the present level of commercial operations, the new system is competitive with systems using current replacement ship types. (3.) Evidence indicates that the new high speed system will generate substantially more commercial cargo than systems using the current replacement type ships. With the resulting improvement in the level of operations, the total cost of marine transportation may be reduced by as much as 30 per cent. (4.) In the new high speed system, under commercial conditions, nuclear power is competitive with conventional power on short routes (Trans-Atlantic), and superior on the longer routes (Trans-Pacific). (5.) Under policy changes which would reflect the national interest in the development of the new system, nuclear power is clearly superior to conventional on both long and short trade routes. It is concluded that the U. S. Government should encourage the development of the new high speed nuclear powered marine transportation system. Two different reactor concepts are evaluated for the new system, the Babcock & Wilcox Consolidated Nuclear Steam Generator (CNSG), and the General Electric Company's gas-cooled reactor (630 A). The CNSG is a development of existing proven pressurized water-cooled and water-moderated reactor technology, with a very low fuel cycle cost, and is recommended for maritime nuclear propulsion plants for construction in the immediate future. It is concluded, however, that because of its extreme versatility, its essential economic parity, and its very desirable safety characteristics, the 630 A reactor plant offers a much greater potential for future maritime ap-

plications. On the basis of this potential, it is recommended that the U. S. Government aggressively support the development of the 630 A prototype. (auth)

35204 (TID-3561(Rev.4)) SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP). A Literature Search. Henry D. Raleigh, comp. (Division of Technical Information Extension, AEC). June 1964. 80p.

A bibliography of 324 references to publications on the SNAP program and related nuclear-powered generators is presented. The references cover the period Jan. 1956 through April 15, 1964. Author and report number indexes are included. (C.E.S.)

35205 REACTORS FOR PROPULSION. C. E. Wise. Machine Design, 36: No. 10, 198-206(Apr. 23, 1964).

Some advantages, difficulties, and developments in the use of reactors in ships, rockets, and ramjets are summarized with specific references to the Pluto and NERVA projects, reactors for maritime propulsion, and naval propulsion systems. (D.C.W.)

35206 QUALITY CONTROL AND NON-DESTRUCTIVE TESTING IN THE CONSTRUCTION OF MARINE NUCLEAR POWER PLANT. PART I. W. H. Sansom (Vickers-Armstrongs (Shipbuilders), Ltd., Barrow-in Furness, Eng.). Shipbuilder Marine Engine-Builder, 569-73(Dec. 1963).

The techniques currently used in nondestructive examination of metal structures are discussed, including visual inspection, dye penetrant inspection, etching and anodic inspection, magnetic flow detection, and eddy current testing. Procedures, limitations, and merits are considered. (D.C.W.)

35207 QUALITY CONTROL AND NON-DESTRUCTIVE TESTING IN THE CONSTRUCTION OF MARINE NUCLEAR POWER PLANT. PART II. W. H. Sansom (Vickers-Armstrongs (Shipbuilders), Ltd., Barrow-in-Furness, Eng.). Shipbuilder Marine Engine-Builder, 34-8(Jan. 1964).

Techniques for detection and measurement of gas leaks are briefly described, and some developments in radiographic examination of metal structures (particularly welds) are discussed. (D.C.W.)

35208 QUALITY CONTROL AND NON-DESTRUCTIVE TESTING IN THE CONSTRUCTION OF MARINE NUCLEAR POWER PLANT. PART III. W. H. Sansom (Vickers-Armstrongs (Shipbuilders), Ltd., Barrow-in-Furness, Eng.). Shipbuilder Marine Engine-Builder, 77-81(Feb. 1964).

The principles and limitations of ultrasonics testing are summarized, together with the development of transducers and the examination of thin metal sheets using Lamb waves. Acceptance standards and the significance of weld defects are also considered. (D.C.W.)

35209 THE SAFETY OF NUCLEAR REACTORS ON MERCHANT SHIPS. Franco Spinelli. Tec. Ital., 28: 797-812(Dec. 1963). (In Italian)

Reactor safety on merchant ships is discussed with consideration of the possible conventional naval incidents – fire, collision, tons of flotage or stability, stranding, and explosions. The protection of the reactor room in each situation is indicated. Avoidance of collisions is emphasized, and the results of experiments with models are given. It is concluded that safety of the reactor room can be assured on vessels over 20 m in width. (D.C.W.)

35210 THE ELECTRICALLY PROPELLED LUNAR LOGISTIC VEHICLE. R. Rhoads Stephenson (California Inst. of Tech., Pasadena). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-497, 15p. $1.00. (CONF-600-8)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

A parametric analysis of an electrically propelled lunar logistic system is presented. A performance index, which is the ratio of the gross payload delivered to lunar orbit during the lifetime of the nuclear-electric powerplant to the total weight placed into the initial Earth orbit during the same period of time, is evaluated. Curves describing the performance index as a function of the powerplant mass fraction (and the corresponding thrust device specific impulse) for various round trip flight times and powerplant lifetimes are presented. For any given case, there is an optimum allocation of mass to the powerplant, and these optima are presented in summary curves showing the best performance index obtainable with a given powerplant specific weight for a specified flight time and powerplant lifetime. For first generation powerplants, which may be heavier and have a shorter lifetime than ultimately expected, one-way trips may be desirable and applicable results are presented. An electrically propelled lunar logistic system based upon the Saturn V launch vehicle is described, and the performance is found to be significantly better than that obtained with chemical or direct-heated nuclear rocket systems using the same launch vehicle. (auth)

35211 APPLICATIONS OF SNAP-50 CLASS POWERPLANTS TO SELECTED UNMANNED ELECTRIC PROPULSION MISSIONS. W. R. Fimple and T. N. Edelbaum (United Aircraft Research Labs., East Hartford, Conn.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-494, 14p. $1.00. (CONF-600-26)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The results of analyses of a number of selected unmanned scientific and logistic space missions are presented, including solar, Jupiter, and Saturn probes; a Venus satellite; and a continuous lunar logistic supply operation. For each mission the potential of electric propulsion (ion rockets powered by the SNAP-50 space nuclear power generating system) is evaluated and compared to the potential of solid-core nuclear-rocket propulsion. The comparisons are made on the basis of performance (payload vs mission time) for the interplanetary missions and on the bases of both performance and cost for the lunar supply operation. The performance results of electric propulsion for the interplanetary missions are presented in plots containing contours of constant power conversion efficiency (i.e., input electric power/thrust power) and constant specific impulse. These plots may be used with reasonable accuracy to evaluate the performance of any thruster with a known variation of efficiency with specific impulse. (auth)

35212 BEHAVIOR OF SNAP 10A DURING ORBITAL REENTRY. Donn K. Nelson (Atomics International, Canoga Park, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-473, 9p. $1.00. (CONF-600-27)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The reentry behavior of the SNAP 10A system was analyzed to gain information on the ablation of various radioactive reactor components. The results show that the SNAP 10A vehicle has aerodynamic stability with the reactor pointed forward into the air-stream and oscillates about the flight path during reentry. The amplitude and frequency of the oscillations were analyzed with respect to time and altitude for a system with two degrees of freedom. It was found that the reactor vessel completely ablates by 240,000

ft, exposing the fuel to enough aerodynamic heating for burnup. (D.C.W.)

35213 CONTROL PROBLEMS DURING STARTUP OF SOLID CORE NUCLEAR ROCKETS. W. W. Little, Jr., E. A. Mason, and K. F. Hansen (Massachusetts Inst. of Tech., Cambridge). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-390, 6p. $1.00. (CONF-600-32)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The reactivity variations induced in graphite-moderated rocket reactors fueled with ^{235}U by homogeneous changes in core temperature and hydrogen density were calculated using a multigroup model. The reactivity variations induced in the reactor core by changes in hydrogen density and core temperature were also calculated as a function of time during startup. (D.C.W.)

35214 A SUMMARY OF NUCLEAR ROCKET APPLICATIONS. Paul G. Johnson (AEC-NASA Space Nuclear Propulsion Office, Washington, D. C.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-388, 7p. $1.00. (CONF-600-34)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

Applications of nuclear rockets to manned lunar exploration beyond the initial landings and the subsequent operations using Apollo-type hardware, unmanned planetary missions involving heavy payloads, and manned missions to the near planets are discussed. Initial weight and operational and propulsion system requirements are considered, as well as payload capabilities. (D.C.W.)

35215 NUCLEAR POWERED SURFACE EFFECT SHIPS DESIGN PROBLEMS. Rudolfo A. Montes de Oca and H. M. Simpson (Booz-Allen Applied Research Inc., Bethesda, Md.). New York, American Inst. of Aeronautics and Astronautics, Preprint 64-186, 18p. $1.00 (CONF-609-1)

From AIAA General Aviation Aircraft Design and Operations Meeting, Wichita, Kan., May 1964.

A preliminary analysis of the feasibility, economics, design, and performance of a nuclear surface effect (air cushion) ship for transocean service is summarized. A 6,000-ton vessel on the North Atlantic route, primarily, is considered. Notably, a reduction in nuclear power plant weight is required. (D.C.W.)

35216 A SURVEY OF SPACE NUCLEAR PROPULSION. Harold B. Finger, James Lazar, and James J. Lynch (National Aeronatucis and Space Administration, Washington, D. C.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-523, 156p. $1.00. (CONF-600-2)

From American Institute of Aeronautics and Astronautics 1st Annual Meeting, Washington, D. C., June-July 1964.

The development status of nuclear propulsion systems is discussed. The systems include solid reactor core nuclear rockets and electric propulsion. A brief review is given of advanced rocket reactor concepts including liquid, dust bed, and gas core reactors. Numerous photographs and performance parameter tabulations are included. (C.E.S.)

35217 NUCLEAR REACTOR. Ronald Peter Williams (to United Kingdom Atomic Energy Authority). British Patent 964,760. July 22, 1964. Filed Jan. 8, 1963.

A boiling reactor is designed with means for controlling its reactivity by varying the coolant recirculation through the core. The reactor has a recirculation line with a core by-pass line which communicates with an injector for injecting liquid coolant into boiling coolant in the core to cause condensation. A valve in the by-pass line provides simultaneous control of the recirculation rate and the injection rate. An embodiment of the reactor is described which is coupled to a steam turbine for marine propulsion. (D.L.C.)

Research and Test Reactors

Refer also to abstracts 34050 and 35148.

35218 (IA-892) REACTOR PHYSICS RESEARCH AT THE ISRAEL RESEARCH REACTOR IRR-1. S. Yiftah, G. Ben David (Davis), I. Segal, W. Rothenstein, A. E. Gileadi, and S. A. Scott (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Sept. 1963. 25p. (CONF-426-4)

From IAEA Study Group Meetings on Research Reactor Utilization, Athens, Sept. 1963.

Research projects at the IRR-1 are reviewed: natural $U-H_2O$ lattice measurements, transfer function measurements, threshold detectors for fast-neutron flux measurements, pulsed-neutron methods, and noise techniques in kinetics analyses. (R.E.U.)

35219 (IA-894) NUCLEAR EDUCATION AND TRAINING AT THE ISRAEL RESEARCH REACTOR IRR-1. S. Yiftah, A. E. Gileadi, C. Braudo, S. Amiel, and R. Arbel (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Sept. 1963. 10p. (CONF-426-6)

From IAEA Study Group Meeting on Research Reactor Utilization, Athens, Sept. 1963.

Operator training and research programs at IRR-1 are reviewed. (R.E.U.)

35220 (IDO-16883) REPORT OF THE SPERT I DESTRUCTIVE TEST PROGRAM ON AN ALUMINUM, PLATE-TYPE, WATER-MODERATED REACTOR. R. W. Miller, Alain Sola, and R. K. McCardell (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 1964. Contract AT(10-1)-205. 187p.

In response to the need for an understanding of destructive mechanisms in aluminum plate-type cores, the Spert project conducted a series of reactor tests in which sudden insertions of excess reactivity were successively increased for each test until, in two such tests, melting temperatures were experienced over small fractions of the core but with no other unusual behavior noted. In a final test which partially melted approximately 35 percent of the core, large pressures were suddenly produced after the power excursion. These pressures in combination with widespread melting were responsible for completely destroying the core, dispersing melted fuel, damaging other reactor hardware, and causing the release of about 0.7 percent of the fisside content of the core to the atmosphere. The explosion phenomenon was qualitatively absent in all previous tests and was in that sense not predictable. A chemical reaction between aluminum and water was detected and estimated to have released about 4 Mw-sec of energy. However, results of the test indicate the existence of a triggering mechanism which dispersed the melted fractions of the core into fragments which were conducive to the chemical reaction. Conditions in the core were favorable for the initiation of a steam explosion, and consequently this mechanism was proposed both as a triggering device and as a contributor to the overall explosion. (auth)

35221 (ORNL-3626(p.3-58)) MSRE DESIGN, ENGINEERING ANALYSIS AND COMPONENT DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

The status of design, procurement, and construction of the Molten Salt Reactor Experiment is outlined. The development of components for MSRE is also discussed. Reactivity parameters of MSRE, as well as criticality characteristics of MSRE auxiliaries, are determined. (T.F.H.)

35222 (ORNL-TM-632) WATER-LOSS TEST AT THE LOW INTENSITY TESTING REACTOR. J. A. Cox and C. C. Webster (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 27p.

The water-loss experiments performed at the LITR during 1951, 1952, and 1953 to determine the temperature rise of the fuel elements due to the decay heat of the fission products when the water was suddenly drained from the reactor are discussed. Tests were performed with the reactor operating at several power levels up to 2300 kw with and without an auxiliary cooling system. (auth)

35223 (STL-372-6) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Quarterly Progress Report for Period Ending June 30, 1964. L. B. Wentz and S. M. Zivi (Thompson Ramo Wooldridge Inc. TRW Space Technology Labs., Redondo Beach, Calif.). July 15, 1964. Contract AT(04-3)-372. 43p.

Measurements of rapid transient steam-void formation, carried out during msec power excursions in KEWB, are reported. The destructive pressure pulse in the SPERT ID reactor is analyzed, with emphasis on the energy transfer and heat transfer aspects of the analysis. (T.F.H.)

35224 THE HITACHI TRAINING REACTOR (HTR). Kiyomi Kiryu and Shōichi Terasawa (Hitachi Ltd., Tokyo). Hitachi Rev., 12: No. 1, 5-12(Feb. 1963).

The Hitachi Training Reactor, constructed in Ozenji, Kawasaki City, went critical at the end of December, 1961. It is a reactor of the tank type with an experimental pool and has a rated thermal output of 100 kw. The average thermal neutron flux of the core is 1.4×10^{12} n/cm^{2}s, and as fuel it uses 10% enriched UO_2 pellets. In designing this reactor, chief emphasis was placed on safety, and various new design features were incorporated for convenience in experiments and training. It is the first nuclear reactor built in Japan with purely domestic scientific know-how. (auth)

35225 PRELIMINARY CALCULATION FOR EXPERIMENTS USING OSAKA UNIVERSITY HITS. I. TIME-DEPENDENT THERMAL NEUTRON ANGULAR FLUX FROM A PULSED EXPONENTIAL ASSEMBLY CALCULATED IN P_3-APPROXIMATION OF THE TRANSPORT EQUATION. Hisashi Hishida, Tamotsu Sekiya, and Tokuo Suita (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 1: 79-86(June 1964).

In order to discuss the ambiguity inherent in the diffusion approximation applied to a small-sized medium including a pulsed neutron source, the time variation and the spatial distribution of thermal neutron angular flux are calculated in P_3-approximation of the time-dependent Boltzmann transport equation. With the discussion on the existence of a set of real and complex eigenvalues, the real eigenvalues for the lowest and some higher modes are computed numerically and the corresponding eigenfunctions are derived under Marshak's boundary condition. The results are compared with those obtained in the diffusion approximation and the physical interpretations of resultant asymptotic and non-asymptotic thermal neutron flux are given. (auth)

35226 HIGHER POWER FROM POOL REACTORS. HOT WATER LAYER RAISES PERMISSIBLE LEVELS. G. Denilou (CEN, Grenoble, France). Nucl. Eng., 9: 249-50(July 1964).

The use of a hot water layer at the top of the pool to control surface activity, thereby permitting higher reactor powers, is discussed. Layer stability, a flow arrangement, and future improvements are considered. Powers to 50 Mw appear possible with freedom of access to the water surface. (D.C.W.)

35227 CONTROL OF SILOE. Andre Sala (Merlin and Gerin, Grenoble, France). Nucl. Eng., 9: 251-2(July 1964).

The control system of the 10-Mw (thermal) reactor, which features semiconductor circuitry, is outlined. Power, measurement, command, and safety systems are covered, together with some technological aspects. (D.C.W.)

35228 CALCULATION OF TELLURIUM AND IODINE FISSION-PRODUCT ACTIVITIES. K. Boddy, R. F. Mathams, and F. H. Weller (Associated Electrical Industries Ltd., Aldermaston, Berks, Eng.). Nucleonics, 22: 130-4(Aug. 1964).

Fission product buildup was computed for irradiation times from ten minutes to equilibrium. A method of using the data presented for individual cases such as the discontinuous operation typical of research reactors is discussed since the buildup is greatly influenced by the particular program. Fission products of ^{131}I, ^{132}I, ^{133}I, ^{134}I, ^{135}I, ^{131}Te, ^{132}Te, ^{133}Te, ^{134}Te, and ^{135}Te were considered. (C.E.S.)

35229 RESEARCH REACTOR AT ISLAMABAD. Syed R. Hussain. Trade Ind., 8: 510-13(Apr. 1964).

The 5-Mw swimming pool reactor and associated facilities are briefly described, and the materials and techniques being used in construction of the reactor building and exhaust tower are summarized. (D.C.W.)

35230 A NUCLEAR IRRADIATION ENCLOSURE ARRANGEMENT. Charles de Bagneaux, Georges Dupont, Franco Franzetti, and Maurice Seguin (to Commissariat à l'Energie Atomique). British Patent 965,887. Aug. 6, 1964. Priority date June 29, 1962, France.

A sealed enclosure for irradiations is designed for use in a swimming-pool reactor. The enclosure includes a L-shaped support, from which the enclosure may readily be removed for replacement or repair. (D.L.C.)

35231 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Bernard Lerouge (to Commissariat à l'Energie Atomique). British Patent 966,366. Aug. 12, 1964. Priority date July 16, 1962, France.

A fuel plate assembly with consumable poison is designed for swimming-pool reactors. The poison, which is preferably in the form of boronated aluminum plates, is located in the outer plates of the assembly. The concentration of the poison is predetermined by the core half life and the position of the elements in the core. The assembly results in simplified fabrication and flux flattening. (D.L.C.)

35232 NUCLEAR REACTOR WITH IMPROVED BEAM TUBE. Charles N. Kelber (to U. S. Atomic Energy Commission). U. S. Patent 3,140,236. July 7, 1964.

A reactor is described, which comprises a core, a beryllium reflector surrounding the core, and a horizontal beam tube penetrating the reflector and has a layer of light

water immediately adjacent to the tip of the beam tube. The layer of water is separated from the core by a layer of beryllium. (AEC)

35233 NEUTRONIC REACTOR. William M. Breazeale, Milton C. Edlund, and Bernard A. Mong (to Babcock and Wilcox Co.). U. S. Patent 3,140,980. July 14, 1964. Filed May 9, 1960.

A pressurized-water reactor for fuel test purposes is described. The fuel elements, reflector elements, control rods, and test spaces are arranged to provide a substantially constant neutron flux in the test regions. The core and pressure vessel are described. The major concentration of the vertical fuel elements are arranged parallel to each other and contiguous to a common plane of reflector elements disposed about the fuel element to form a testing space. (R.E.U.)

WASTE DISPOSAL AND PROCESSING

35234 (HW-81862) RESEARCH AND DEVELOPMENT ACTIVITIES. FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, January–March 1964. A. M. Platt, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1964. Contract AT(45-1)-1350. 44p.

Glass samples were prepared from a simulated Purex waste spiked with massive quantities of radiocerium. Laboratory studies on glass formulations showed variations in drip temperature as a function of fission product content and sulfate-phosphate content. A marked phosphate loss occurred with some of the mixtures during calcination and melting. Capacity studies on a mockup of the 14-in. spray calciner have verified the desired capacity of 10 gph. Other tests have indicated unusually high water capacity with an ultrasonic atomizing nozzle. Computer studies show that the maximum size of a container for radioactive material may be limited by transient conditions during fixation-stabilization rather than equilibrium storage conditions. Pilot plant pulse column studies using BAMBP to extract cesium from Purex alkaline waste were completed with satisfactory results. Laboratory studies were conducted to evaluate several methods of eliminating or minimizing ammonium ion in the scrub effluent from zeolites loaded with cesium from Purex supernatant waste. The temperatures that would be experienced in solidifying wastes in large underground tanks were predicted as a function of waste and soil thermal conductivities and waste heat generation rates. Electrodialysis and electrodeionization techniques for removal of ruthenium from intermediate-level wastes are being examined. An investigation of the use of zeolites in neutron irradiation applications was initiated. (auth)

35235 (IDO-12036) REMOVAL OF COBALT AND CHROMIUM BY PRECIPITATION AND ION EXCHANGE ON SOIL, LIGNITE AND CLINOPTILOLITE FROM CITRATE-CONTAINING RADIOACTIVE LIQUID WASTE. D. B. Hawkins (Idaho Operations Office. Health and Safety Div., AEC). June 1964. 24p.

Laboratory studies indicate that ^{60}Co and ^{51}Cr can be removed from separate waste streams containing ammonium citrate and alkaline permanganate by a combined process of precipitation and ion exchange. The general procedure used was to neutralize the alkaline permanganate with sulfuric acid and to combine this solution with the ammonium-citrate solution causing the oxidation of the citrate. The Co and Cr originally present as complex anions were converted to cationic form by this process and scavenged from solution by the manganese-dioxide precipitate formed by reduction of the permanganate. The Co and Cr remaining in solution were then removed by ion exchange on lignite, soil, and clinoptilolite. Distribution coefficients for Co and Cr were 56 and 1.2, 800 and 36, and 24 and 0.1 for soil, lignite, and clinoptilolite respectively. Lignite used in combination with the oxidation-precipitation step resulted in the removal of 99.7% of the ^{60}Co and 95.1% of the ^{51}Cr from the waste streams. (auth)

35236 (ORNL-3612) LABORATORY DEVELOPMENT OF PROCESSES FOR FIXATION OF HIGH-LEVEL RADIOACTIVE WASTES IN GLASSY SOLIDS: WASTES CONTAINING (1) ALUMINUM NITRATE AND (2) THE NITRATES OF THE CONSTITUENTS OF STAINLESS STEEL. W. E. Clark and H. W. Godbee (Oak Ridge National Lab., Tenn.). July 1964. Contract W-7405-eng-26. 59p.

Glassy solids satisfactory for the long-term storage ("ultimate disposal") of radioactive wastes were prepared from solutions simulating those obtained or expected from aqueous reprocessing of aluminum- and stainless steel-bearing fuel elements. Only tracer levels of radioactivity were tested. Vapor-liquid equilibria and solution densities were determined for both waste types over wide ranges of composition. Phosphate was the principal fluxing agent in all products reported. Borate and sodium were employed as other additives with both waste types. Aluminum generally improved the glassiness of the products obtained with stainless steel waste, while lead was helpful in lowering the softening temperature of the melts obtained with the aluminum waste. Volume reductions (volume of waste solution/volume of glass) varied from 7.2 to 9.3 for the aluminum waste and from 2.5 to 6.6 for the stainless steel waste. Leaching tests on small specimens of the more satisfactory solids prepared from both waste types gave dissolution rates of about 10^{-6} g/cm^2 day based on the fraction of ^{137}Cs spike leached from the product. Semicontinuous fixations of both waste types were run on a semiengineering scale. These were highly successful for the aluminum waste. The melt used for fixation of the stainless steel waste was excessively corrosive and produced a solid containing excessive voids. Use of stainless steel fixation pots appears feasible with both waste types, but titanium is preferred for the construction of an evaporator for concentration of the waste solution. Thermal conductivity of one aluminum-type glass varied from 1.05 Btu hr^{-1} ft^{-1} °F at 300°F to 1.60 Btu hr^{-1} ft^{-1} °F^{-1} at 1050°F. Fixation of both waste types in phosphate "glasses" is feasible on the basis of current technology. Further work needs to be done to define the compositions of products having optimum properties. (auth)

35237 (ORNL-3629) CONVERSION OF SIMULATED HIGH-LEVEL RADIOACTIVE WASTE SOLUTIONS TO GLASSY SOLIDS IN A POT BY A RISING LIQUID LEVEL METHOD: THE RL-POTGLASS PROCESS. H. W. Godbee and W. E. Clark (Oak Ridge National Lab., Tenn.). Aug. 1964. Contract W-7405-eng-26. 25p.

The permanent disposal of reactor wastes very probably will require their burial as solids. If so, glassy solids may be more desirable than porous solids, such as calcined oxides. Twelve experiments were completed using a rising-liquid-level (RL-Potglass) process for the conversion of high-level radioactive waste solutions to glassy solids in a 4-in.-dia and 24-in.-long pot at average feed rates of 32 to 45 ml/min. The procedure, the results, and the operating difficulties encountered during these experiments are described. Fixation of TBP-25 (aluminum), Purex, and Darex (stainless steel) simulated high-level wastes was demonstrated; phosphate was used as the principal fluxing agent. Other added ions include aluminum, lithium, sodium, calcium, boron, and lead. The glassy solid obtained with TBP-25 waste had a density of 2.86 g/cm^3, contained 26 wt % oxides from waste, and represented a volume reduction (volumes of waste per volume of solid product) of 8. The "noncorrosive" product obtained with Purex (FTW-65) waste had a density of 2.41 g/cm^3, contained 44.5 wt % oxides from the waste, and represented a

volume reduction of 36. The solid product from a single experiment with Darex waste contained 25 wt % oxides from the waste and represented a volume reduction of 5. It was concluded that glassy solids could also be formed in pots as an alternative to forming calcined solids in a waste processing plant designed for the conversion of wastes to solids by the pot process. Pressure surges in the pot were successfully held to 2 psi or less, and the levels of boiling solution, calcine, and melt were detected satisfactorily with thermocouples or electrical conductivity probes. Corrosion was satisfactorily low for the Purex and TBP-25 systems. Corrosion was excessive in an initial test with the Darex system when an early melt composition was used. However, the corrosion rates are expected to be satisfactorily low when improved melt compositions are used. (auth)

35238 (STI/DOC/10/28(p.9-20)) RADIOACTIVE WASTE MANAGEMENT AND ENVIRONMENTAL RESEARCH. (International Atomic Energy Agency, Vienna).

Experimental methods and results are reported from investigations of the possibility of using wood as a raw material for the preparation of inexpensive ion exchange materials for use in the treatment of radioactive waste. Cation exchange substances with relatively high capacities were produced at little cost but the cost of anion exchangers was not competitive with that of commercial resins. The influence of radioactive wastes on biological conditions in a river was investigated under carefully controlled laboratory conditions. Data are presented on the sorption of ^{95}Zr, ^{95}Nb, ^{91}Y, ^{144}Ce, and ^{32}P on river sediments; the uptake by algae of ^{32}P, ^{134}Cs, ^{137}Cs, ^{131}I, ^{89}Sr, ^{144}Ce, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{106}Ru, and U; and the uptake of ^{32}P and ^{137}Cs by fish. The uptake, accumulation, and exchange of ^{90}Sr, ^{137}Cs, ^{90}Y, and ^{89}Sr by various open-sea phytoplankton were measured. (C.H.)

35239 PROBLEMS RELATIVE TO THE TREATMENT OF RADIOACTIVE WASTES. M. P. Dejonghe (Societe Belge de Chimie Nucleaire, Mol, Belg.). Bull. Inform. Assoc. Belge Develop. Pacifique Energie At., 9: No. 49, 5-19(Apr. 1964). (In French)

A brief review is given of the problems in the treatment of radioactive wastes. The topics discussed are sources of the wastes, processing techniques, migration of radioisotopes in the soil, special problem of highly active wastes, and economic aspects. (J.S.R.)

35240 TREATMENT OF STRONTIUM-90 BEARING ORGANIC WASTE BY ION EXCHANGE. E. Edgerley, Jr. (Washington Univ., St. Louis) and A. D. Ray. 23p. (CONF-179-10)

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

A laboratory study was undertaken to determine the ability of cation resin to remove a cationic radionuclide form a waste stream in the presence and in the absence of interfering components. Additional studies were made on the removal of ^{90}Sr from a complex organic waste stream in a small plant treatment facility. Special attention was given to leakage or premature breakthrough phenomena of radiostrontium from columns of cation exchange resin. The relationship between leakage amount and the effective resin contact time in the exchange was determined, and the effect of liquid waste stream characteristics on leakage amounts was ascertained. A strong acid, high capacity, sulfonated polystyrene divinyl benzene resin, Duolite C-20 (Na^+), was used. Decontamination of liquid wastes containing ^{90}Sr by ion exchange is described adequately by ion exchange theory. The presence of organic matter in the liquid waste stream exerts at least a two-fold effect: loss of exchange capacity of the resin; and increase in quantity of leakage of ^{90}Sr. Studies made on a plant scale treatment facility are described briefly. (P.C.H.)

GENERAL AND MISCELLANEOUS

35241 (AECL-1972) ANNUAL REPORT, 1963-64. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 35p.

The annual report of Atomic Energy of Canada Limited for the fiscal year ended March 31, 1964, together with the financial statements and the auditor's report are presented. Information is given of the nuclear power program, Chalk River Nuclear Laboratories, Whiteshell Nuclear Reseacrh Establishment, Commercial Products Division, international co-operation, administration, and highlights of the year. (N.W.R.)

35242 (CALT-221-2) RECOIL ELECTRON RESONANCE IN CRYSTALS AND THE STOKES AND ANTI-STOKES MODIFIED LINES IN X-RAY SCATTERING. Technical Report No. 27. K. Das Gupta (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). June 1964. Contract AT(94-3)-221. 10p.

A Compton process inside a crystal is discussed. An electron which before the scattering is bound to an atom becomes quasi-free after the scattering process to travel through the crystal with a momentum compensating the change of momentum of the photon. The interaction of the recoil electrons with the crystal is analyzed by considering the condition of resonance with the lattice planes. Stokes and anti-Stokes modified lines appearing in the strong diffuse bands of x-ray scattering on silicon crystals are discussed. (C.E.S.)

35243 (IITRI-1184-13) MAGNETIC PROPERTIES OF INSULATORS. Quarterly Report No. 13, February 16–May 15, 1964. Jordan J. Markham (Illinois Inst. of Tech., Chicago. IIT Research Inst.). June 5, 1964. Contract AT(11-1)-587. 31p.

The saturation of a portion of the electron spin resonance line of F centers in KCl is observed using saturation periods from 10 milliseconds to a minute. Initially the magnetic field is held constant at a value, which is included in the spectrum, until the system has come to thermal equilibrium in the absence of microwave power. Then a saturating pulse is applied. Finally the field is changed so the resonance as a function of field is photographed at a reduced power. The depth and width of the saturated region increase as the length of the pulse increases. The change as the power is increased is much less. At low saturating power and long saturating times, the saturation factor is not symmetrical as a function of observing field about the saturating field. The change in susceptibility as a function of time was measured for various separations between saturating and observing field. An estimate for T_2 can be obtained by using the spin packet theory of inhomogeneous line broadening. However, the most probable transitions presently included in the model do not adequately explain the measurements at any power level or saturation time. (auth)

35244 (KAPL-M-6165) STAT-3: AN INTERPRETIVE PROGRAM FOR LOGICAL OPERATIONS. A. L. Liedel (Knolls Atomic Power Lab., Schenectady, N. Y.). June 15, 1964. Contract W-31-109-eng-52. 20p.

STAT-3 is a library of logical operations in the form of an interpretive program. This program consists of 25 operations to be performed on N × M matrices. The program was written to perform operations on a data matrix, such as digitized video data from the Structural Analysis Machine (SAM). Although the raw data will be limited to a maximum mesh of 200 × 200, STAT-3 will allow for matrices up to 400 × 400 elements. The average running time for this program will depend upon the matrix size and number and type of operations to be performed. STAT-3 was written in TAC language because of the Boolean (logical) nature of the operations and the necessity of working with the individual bits of the data words. STAT-3 is a library component of the SCAN system of data processing programs. (auth)

35245 (LADC-6205) AUTOMATIC LENS DESIGN BY STATISTICAL ANALYSIS. Berlyn Brixner (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 19p. (CONF-632-1)

For presentation at the Lecture at Post-ICO-Meeting Seminar on Lens Design, Tokyo, Sept. 1964.

The development of an IBM 7090 program to statistically design any required lens system is discussed. (R.E.U.)

35246 (MLM-1196) MOUND LABORATORY PROGRESS REPORT FOR APRIL 1964. J. F. Eichelberger, G. R. Grove, and L. V. Jones (Mound Lab., Miamisburg, Ohio). July 10, 1964. Contract AT(33-1)-Gen-53. 30p.

Techniques are discussed for separating and purifying uranium-234 from aged plutonium-238 solutions by a combination of anion exchange and solvent extraction. In the latest ion exchange run 87% of the uranium was separated from 93% of the plutonium. Cold work on the purification of uranium by anion exchange from a high nitrate salt, low nitric acid medium continued. In eight runs an average 99.7% copper and 98.6% iron were removed from solution. A solvent extraction procedure also being investigated for purifying uranium gave an average 97.3% recovery. The optical absorption spectra of the complex ions $PoCl_6^=$, $PoBr_6^=$, and $PoI_6^=$ were obtained. The colors of the anion complexes were due to charge transfer absorptions in which electrons in metal orbitals were excited to orbitals localized mainly on the ligands. Tentative decay schemes for polonium-208 and polonium-209 were determined. Actinium-227 tracer was used in testing the ion exchange separation of that isotope from its daughter products. All of the daughter products were eluted by 1.75 M nitric acid. Actinium was eluted with 6 M nitric acid, and thorium-227 was eluted with ammonium acetate. The half life of plutonium-238 was determined by measuring the decay rate of two samples with Calorimeters 39 and 90. Each power measurement was corrected for other isotopes of plutonium, based upon the weight of the samples and analyses by mass spectrometry. By propagation of errors, using the external probable error because it is larger, the half life and probable error of plutonium-238 from this work is 87.48 ± 0.08 years. The thermomolecular pressure corrections to be used in helium-3 vapor pressure thermometry are being determined. A successful superleak and heat flush device was built and operated. Superfluid helium-4 was separated from its normal component and from helium-3 by filtering through a capillary packed with jeweler's rouge. A thermal pump consisting of four alternately heated cylinders is being tested for filling cylinders with helium-3 gas purified by thermal diffusion. Experiments are being performed to enrich carbon isotopes by converting methane to elemental carbon by passing over heated platinum coil (1100–1200°C). Fifty-five days were required to deplete 88% of the 55

liters of neon-20 in the neon-21 system. A pump was added to the recirculating hot calcium purification system for argon-36 to increase the flow of gas through the trap. Krypton-78 and -80 were enriched to 10% in the product. The xenon eight-column, four-stage cascade thermal diffusion system product reached near equilibrium composition. Then the system was revised to a five-stage (3-2-1-1-1) system. An improved cleanup of xenon was obtained when nitrogen replaced helium as the carrier gas in the experimental chromatograph. The neon isotope separation results using a 24-ft thermal diffusion column with a spring tension device and a-c power for heating the center wire were compared with the separation with a similar column and a-c power. The separation factors were similar. A polyurethane base conductive adhesive was formulated which is stable electrically at 160°F. After heating for two weeks at 160°F, the resistivity was 0.13 ohm-centimeter. The geometry of the chamber used for irradiating beryllium samples and the guide tube were modified to prevent rotation of the irradiation chamber about its own axis. The neutron counting tubes were also lowered further into the paraffin thereby placing the center of their active area exactly in line with the beryllium during irradiation. These modifications have increased the count rate per gram of beryllium by a factor of two and eliminated the slight variation in count rate due to radial geometry. Investigations were made on the feasibility of analyzing gas samples by scintillation counting. An anthracene solid scintillator was able to detect 1×10^{-3} mole % tritium in helium-3. With xenon gas as a scintillator to lower the detectable limit of tritium, samples of 1×10^{-4} to 5×10^{-5} mole % tritium in helium-3 were counted. A two-component epoxy coating which is being tested for use in storing thorium residues showed no deleterious effects after two months' exposure to alpha radiation. (auth)

35247 (NAA-SR-9700) AEC UNCLASSIFIED PROGRAM. Quarterly Technical Progress Report, January–March 1964. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 19, 1964. Contract AT-11-1-GEN-8. 220p.

Operation of the Sodium Reactor Experiment was continued. Equipment for nondestructive and fuel surveillance in the HNPF maintenance cell was designed. Equipment is being developed to examine irradiated Piqua fuel elements. Radiometric analysis of samples obtained from two UC fuel capsules in TREAT was completed. The AIREK digital computer code and modified versions of it were used to study simulated reactor transients and for hazards analysis. The siting code, AISITE, was reprogrammed to allow more flexibility and to improve physical models. The theory of the propagation of a burst of thermal neutrons through an extended multiplying system was formulated. The air leak rate of concrete and metal modes of reactor housing installations was studied. Activation measurements of the resonance integral of gold and ^{238}U were completed. Small-scale sodium burning experiments were carried out. Examination of UO_2 fuel, reprocessed and reirradiated, was initiated. Problems in activating slugs of properly stored UC were studied. The loss of plutonium by evaporation during reconversion and refabrication was investigated. Progress on programs on reactor physics, uranium carbides, beryllium oxide, metal-hydrogen systems, neutron flux monitor, high-temperature chemistry, radiation chemistry, electronic structure of metals and alloys, and radiation damage in crystalline solids. (M.C.G.)

35248 (NIRS-2) ANNUAL REPORT, 1962. (Japan. National Inst. of Radiological Sciences, Tokyo). Dec. 1963. 77p.

Separate abstracts were prepared for eight sections of the report on research activities in physics, chemistry, biology, medicine, and environmental radioactive contamination. (C.H.)

For abstracts of individual sections see: 33231, 33270, 33271, 33272, 33273, 33449, 33805, and 34274.

35249 (SC-R-64-164) RECEIVING CHARACTERISTICS OF TWO-WIRE LINES EXCITED BY UNIFORM AND NON-UNIFORM ELECTRIC FIELDS. C. W. Harrison, Jr. (Sandia Corp., Albuquerque, N. Mex.). May 1964. Contract [AT(29-1)-789]. 14p.

Sandia Corp. Monograph.

The receiving properties of an isolated two-conductor transmission line terminated at each end in arbitrary values of impedance are deduced by directly integrating over the length of the wires the differential value of the plane-wave incident electric field exciting the line. For identical configurations it is shown that this theory and the theory of folded receiving antennas are compatible. Formulas for the load currents are obtained for a transmission-line loop oriented parallel to and in the near-zone field of a receiving and scattering antenna. The line and the antenna are not necessarily the same length. (auth)

35250 (STI/DOC/10/28) IAEA RESEARCH CONTRACTS. Fourth Annual Report. (International Atomic Energy Agency, Vienna). Technical Reports Series No. 28. Apr. 1964. 135p.

Separate abstracts were prepared for seven sections of this report on results obtained during 1963 under the International Atomic Energy Agency contract program. A list is included of 75 publications during 1963 resulting from research performed under the contracts. (C.H.)

For abstracts of individual sections see: 33213, 33214, 33277, 33278, 35065, 35066, and 35238.

35251 (TID-85(3rd Rev.)) REPORT NUMBER SERIES USED BY THE DIVISION OF TECHNICAL INFORMATION IN CATALOGING REPORTS. Hannah B. Mayfield and Helen W. White, comps. (Division of Technical Information Extension, AEC). July 1963. 172p.

Three lists are presented: an alphabetical listing of report series codes identified with the corporate or issuing organization, a listing of the organizations and the report series they have used, and a listing of report numbering systems used by some of the organizations whose reports have been catalogued by the Division of Technical Information Extension. (D.L.C.)

35252 (UCRL-7898) SOME UNSOLVED PROBLEMS OF EXPLOSIVE SENSITIVITY. Edward James (California. Univ., Livermore. Lawrence Radiation Lab.). June 1, 1964. Contract W-7405-eng-48. 9p. (CONF-634-1)

For presentation at American Ordnance Association Propellants and Explosive Section Meeting, Wright-Patterson AFB, Ohio, Sept. 1964.

Explosive sensitivity actually relates to shock initiation, mechanical ignition, and chemical reactivity of the explosive. The unsolved problems in mechanical ignition (ignition by impact) are considered in some detail. An experimental program on simple geometrical explosive-plastic-metal arrangements is described which indicates that only four mechanisms are actually operative: slippage across a fracture plane, extrusion, shear with grit, and impact of loose explosive. The behavior of PBX 9404, PBX 9010, LX-04-1, and Comp B-3 explosives under these four mechanisms is described. It is suggested that the described methods for evaluating the safety of explosives un-

der impact conditions can be applied to propellants. (D.L.C.)

35253 (UCRL-11001) KINETICS AND MECHANISM OF THE ANATASE-RUTILE TRANSFORMATION (thesis). Robert Day Shannon (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 20, 1964. Contract W-7405-eng-48. 97p.

The anatase-rutile transformation was studied using both single crystals and powders. Rutile crystallites that formed when anatase single crystals were heated at 900 to 950°C were found to exhibit preferred orientation. A study of the orientation led to a mechanism similar to that of the brookite-rutile transformation. The mechanism involves retention of the {112} pseudo-close-packed planes in anatase and rearrangement of the titanium and oxygen ions within the plane. A cooperative movement of the titanium and oxygen ions is proposed in which the majority of the titanium ions, in order to reach their new sites, break two of their original six Ti–O bonds. Nucleation and growth in anatase thin sections were followed under a hot-stage microscope. Both occurred preferentially at edges, corners, and inclusions. Growth spread two-dimensionally over the surface in some crystals, and propagated three-dimensionally from point sources in others. Transformation of three commercial anatase powders resulted in sigmoid transformation curves, which were interpreted in terms of a nucleation-growth process. Analysis of these curves by means of several rate laws led to activation energies for nucleation of 110, 135, and 150 kcal/mole, and for growth of 100, 115, and 190 kcal/mole for the three materials. A literature review made of the effects of impurities on the transformation suggested that the rate of transformation is governed by the defect structure of the TiO_2, i.e., by the concentration of oxygen vacancies or titanium interstitials. In this study, both CuO additions and a hydrogen atmosphere were found to accelerate the transformation. It is proposed that (a) CuO accelerates the transformation by formation of a substitutional solid solution and a consequent increase in oxygen-vacancy concentration, and (b) hydrogen accelerates the transformation either by the introduction of oxygen vacancies or by reduction to a second Ti_nO_{2n-1} Magnéli phase. A vacuum of 3×10^{-4}-mm Hg was found to retard the rate of transformation. This was attributed to the introduction of titanium interstitials. (auth)

35254 (UCRL-11189) CHEMISTRY OF DIPHOSPHORUS TETRACHLORIDE (thesis). Charles B. Lindahl (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 16, 1964. Contract W-7405-eng-48. 63p.

If a microwave discharge is established in a stream of PCl_3 vapor at 1 to 5 mm pressure, the emerging vapor contains metastable species of remarkably long lifetimes. These species react or disproportionate at cold surfaces to give PCl_5, PCl_3, and red and yellow-tan phosphorus-like subchlorides of phosphorus (e.g., P_5Cl). Part of the metastable species remains for at least 3 hr after the initial discharge reaction. A plug of bronze wool placed past the PCl_3 discharge reacts to form CuCl. No PCl_5 or red or yellow-tan solids are formed in the subsequent cold traps, but small amounts of P_2Cl_4 are found. The data are consistent with the assumption that the vapor leaving the PCl_3 discharge contains PCl_5 and one or more of the reduced species P, P_2, or PCl. The presence of the radical PCl_2 in any significant amount is not consistent with the data. Diphosphorus tetrachloride, with a lone pair of electrons on each phosphorus, can react as a monofunctional or difunctional Lewis base. Nickel carbonyl and P_2Cl_4 can react at 0°C to form a series of compounds whose relative amounts depend upon the relative ratios of the reactants and the CO pressure in the reaction vessel. A large excess of $Ni(CO)_4$ reacts with P_2Cl_4 to form the yellow-white solid $P_2Cl_4 \cdot 2Ni(CO)_3$. In the absence of CO pressure of at least 0.3 atm this material decomposes at 0°C. With equal molar amounts of P_2Cl_4 and $Ni(CO)_4$, a yellow solid is formed having the approximate empirical formula $P_2Cl_4 \cdot Ni(CO)_2$. A polymeric structure $[P_2Cl_4 \cdot Ni(CO)_2]_x$ with terminal groups of P_2Cl_4 or $Ni(CO_3)$ is suggested for this material. Large excesses of P_2Cl_4 react with $Ni(CO)_4$ to form a yellow-brown solid $(P_2Cl_4)_2 \cdot Ni(CO)_2$. If the CO pressure in the reaction vessel does not build up to ≥0.7 atm by the evolution of CO in the formation of this compound, the compound continues to react slowly with P_2Cl_4 to yield compounds approaching the compositions $(P_2Cl_4)_3NiCO$ and $Ni(P_2Cl_4)_4$ until the CO pressure does reach 0.7 atm. Experiments with PCl_3, P_2Cl_4, and $Ni(CO)_4$ show that P_2Cl_4 can replace PCl_3 in $(PCl_3)_{4-x} \cdot Ni(CO)_x$ compounds and that in mixtures of PCl_3 and P_2Cl_4 with $Ni(CO)_4$ most of the reaction is due to P_2Cl_4. Thus, P_2Cl_4 is a better Lewis base than PCl_3; this is in agreement with an argument based upon the inductive effect. Diphosphorus tetrachloride does not react, or reacts only extremely slowly, at 0° with $Fe(CO)_5$, $Cr(CO)_6$ or $Mo(CO)_6$. With BBr_3 at 0°, P_2Cl_4 reacts to yield PBr_3, BCl_3, the mixed chloro-bromo-trihalides of phosphorus and boron, and phosphorus subhalides. Boron trichloride and BF_3 do not react with P_2Cl_4 at 0°, which is in agreement with the known Lewis acid trend $BBr_3 > BCl_3 > BF_3$. Diphosphorus tetrachloride reacts with B_2H_6 causing decomposition producing H_2, BCl_3, $BHCl_2$, and yellow-orange solids indicative of phosphorus subhalides or subhydrides. Because P_2Cl_4 has vacant low-energy d orbitals on each phosphorus, it is also a potential Lewis acid. No reaction was observed between P_2Cl_4 and C_2H_4, C_2H_2, or C_3F_6 at 0° or at room temperature. However, reaction between P_2Cl_4 and trimethylamine at temperatures of 0° and −78°C produces large quantities of yellow-orange nonvolatile solids. The apparent products of reaction are $PCl_3 \cdot N(CH_3)_3$ and phosphorus. Thus, P_2Cl_4 undergoes reaction both as a Lewis acid and as a Lewis base. However, all reactions except the reaction with $Ni(CO)_4$ involve rupture of the phosphorus-phorphorus bond in P_2Cl_4. (auth)

35255 (UCRL-11410) HYDROLYTIC POLYMERIZATION IN Cr(III) SOLUTIONS (thesis). Gertrude Thompson (California. Univ., Berkeley. Lawrence Radiation Lab.). June 1964. Contract W-7405-eng-48. 108p.

To establish the formulas of two hydrolytic chromium(III) species, equilibrium measurements of the formation of a dimer, $Cr_2(OH)_2^{4+}$, and trimer, $Cr_3(OH)_4^{5+}$, from monomeric $Cr(H_2O)_6^{3+}$ have been carried out using ion-exchange analytical techniques. The decomposition in acid solutions of the dimer can be followed spectrophotometrically and apparently occurs by way of a singly bridged dimeric intermediate, $CrOHCr^{5+}$. Since appreciable concentrations of the intermediate may be prepared, the rate law for the reverse action–intermediate to doubly bridged dimer–can be readily determined: first order in chromium and predominantly hydrogen ion-independent. At lower acidity–below 0.1 M–the rate data indicate appreciable hydrolysis of the intermediate. In solutions of moderate acidity, the further decomposition of the intermediate to monomer can also be followed and has been found to be first order in chromium and hydrogen ion independent. Freezing point depressions at the ice-perchloric acid hydrate eutectic have served to establish the dimeric character of the intermediate as well as to confirm the equilibrium results for

the formation of the two hydrolytic chromium(III) species. ESR measurements of three polynuclear species and the monomer were carried out to determine the g value for each species. Following the method of Kambe, the variation of the magnetic susceptibility as a function of temperature was fitted to a theoretical plot to determine the degree of coupling of spins on adjacent chromium atoms and the nature of the bridging groups. The values reported for J, the exchange coupling constant between chromium atoms, are in substantial agreement with those reported for similar compounds by Earnshaw and Lewis. Comparison with analogous iron(III) dimers indicated that strong π-bonding of the hydroxy groups cannot account for the observed coupling constants and that the results for complexes of both metal ions may better be explained in terms of σ bonding. On the basis of these measurements, the trimer appears to have a linear form. (auth)

35256 IMPORTANCE OF AUTOMATIC PATTERN RECOGNITION TECHNIQUES IN THE EARLY DETECTION OF ALTERED BLOOD-CELL PRODUCTION. M. Ingram (Univ. of Rochester, N. Y.) and K. Preston, Jr. Ann. N. Y. Acad. Sci., 113: 1066-72(Feb. 28, 1964).

There is a vast amount of information about subtly altered hematopoiesis that is present even in routinely prepared films of peripheral blood. Much of this information cannot be utilized at present because of the practical limitations imposed by classical microscopy. Automatic pattern-recognition techniques suitable for identifying blood cells by rapid topographical analysis may be expected to make such information useful. Methods for evaluating, quantitatively, the occurrence and persistence of unusual cells and fluctuations in their rates of occurrence would make it possible to study large groups of persons repeatedly, over periods of many years after exposure to potentially hematotoxic agents, and to determine whether some abnormal cell lines are premonitory of serious disorders in blood cell proliferation. Such methods would also improve differential leukocyte counting, making it possible to routinely classify large numbers of cells, often according to many morphological criteria not presently exploited. (auth)

35257 THE CASE FOR NUCLEAR POWER IN PAKISTAN. I. H. Usmani (Pakistan Atomic Energy Commission). Trade Ind., 8: 473-6(Apr. 1964).

The atomic energy program of Pakistan is outlined, and the necessity for atomic energy in the economic development of the country is discussed in detail. The relation of power consumption to economic development, projected power demands and resources, and the economics of nuclear power are all considered. (D.C.W.)

35258 NEW TITANIUM PRIMER FOR AN EVAPORION PUMP. Edmond C. Hurst (to U. S. Atomic Energy Commission). U. S. Patent 3,140,173. July 7, 1964.

A titanium primer for evapor-ion pumps is described, which comprises a porous tungsten cake formed around a titanium wire. The titanium is melted, causing it to wet and diffuse through the tungsten cake. (AEC)

35259 WEIGHTLESSNESS SWITCH. R. P. Stromberg (to U. S. Atomic Energy Commission). U. S. Patent 3,141,084. July 14, 1964.

An omnidirectional electric switch responsive to gravimetric conditions less than normal is described. The switch has a cavity in an electrically insulated body with a pair of conductors terminating adjacent the center to form a normally open switch. Upon approaching less than normal gravimetric conditions, a liquid in the cavity assumes a generally globular configuration to bridge the conductors and close the switch. (AEC)

CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt.," permitting a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

A

ACADEMIA R. P. R. INSTITUTUL DE FIZICĂ ATOMICA, BUCHAREST.
Poisoning during isotopic exchange reaction between H and H_2O, 18: 33527 (IFA-28-IS)

AEROJET-GENERAL NUCLEONICS, SAN RAMON, CALIF.
Apparatus to measure biaxial creep of materials in Li, 18: 34030 (APL-TDR-64-73)

AERONAUTICAL SYSTEMS DIV., WRIGHT-PATTERSON AFB, OHIO.
Thermonuclear reactions for space propulsion, 18: 34973 (ASD-TDR-63-696)

AEROPROJECTS, INC., WEST CHESTER, PENNA.
Prog. rpt. on ultrasonic instrumentation for nuclear applications, 8–9/62, 18: 33830 (NYO-10556)
Prog. rpt. on ultrasonic instrumentation for nuclear applications, 12/62–1/63, 18: 33831 (NYO-10558)
Prog. rpt. on ultrasonic instrumentation for nuclear applications, 4–5/63, 18: 33832 (NYO-10560)

AEROSPACE CORP., EL SEGUNDO, CALIF.
Creep of Nb at low temperatures, 18: 34119 (ATN-64(9236)-9)

AIR FORCE CAMBRIDGE RESEARCH LABS., LAURENCE G. HANSCOM FIELD, BEDFORD, MASS.
Antenna pattern distortion due to plasma layer, 18: 34968 (AFCRL-64-18)
Nonlinear interaction of EM wave with time-dependent plasma medium, 18: 34970 (AFCRL-64-250)

AKTIEBOLAGET ATOMENERGI, STOCKHOLM.
Neutron activation analysis for 24 trace elements in heart tissue, 18: 33457 (AE-146)
Prog. rpt. on personnel dosimetry, annual, 1963, 18: 33798 (AE-147)

ALLGEMEINE ELEKTRIZITÄTSGESELLSCHAFT, FRANKFURT AM MAIN.
Instability-loop of AEC-atomic power laboratory, 18: 35090 (ANL-Trans-52)
MHD impact flow-tube problem proposal, 18: 35166 (ANL-Trans-38)
Nuclear vapotron, 18: 34090 (EURAEC-1015)

ALLIED RESEARCH ASSOCIATES, INC., CONCORD, MASS.
On-site resistivity and self-potential measurements, 18: 33780 (NP-14145)

ALLIS-CHALMERS MFG. CO., MILWAUKEE.
Prog. rpt. on steam separation technology, 4–6/64, 18: 33693 (ACNP-64026)
Prog. rpt. on vapor volume fraction and slip velocity, 4–6/64, 18: 33729 (ACNP-64027)

ALLIS-CHALMERS MFG. CO. ATOMIC ENERGY DIV., WASHINGTON, D. C.
Experimental gas cooled reactor safety analysis, 18: 35163 (TID-20890)
Experimental gas cooled reactor safety system analysis, 18: 35164 (TID-20891)

AMSTERDAM. INSTITUTT VOOR KERNPHYSISCH ONDERZOEK.
Interactions of deuterons with isotopes of H and He, 18: 34771 (NP-14175)

AMSTERDAM. UNIVERSITEIT.
Interactions of deuterons with isotopes of H and He, 18: 34771 (NP-14175)

AMSTERDAM. VRIJE UNIVERSITEIT.
Lifetimes of nuclear excited states, 18: 34772 (NP-14184)

ARGENTINA. COMISIÓN NACIONAL DE ENERGÍA ATÓMICA, BUENOS AIRES.
Determination of radioactivity of minerals by x rays, 18: 33794 (NP-14176)
Production of I-131 from irradiated UO_2, 18: 33620 (NP-14187)

ARGONNE CANCER RESEARCH HOSPITAL, CHICAGO.
Prog. rpt. on biological research, semiannual, 3/64, 18: 33211 (ACRH-21)

ARGONNE NATIONAL LAB., IDAHO FALLS, IDAHO.
Behavior of cladding materials in H_2O and steam, 18: 34076 (TID-8540(p.213-330))
Boiling "burnout" for reactor design, 18: 35162 (TID-8540(p.131-76))
Commercial power reactors cooled with Na, D_2O, or organic liquids, 18: 35161 (TID-8540(p.71-129))
In-core instrumentation, 18: 35089 (TID-8540(p.177-211))
Metallic fuels, 18: 34130 (TID-8540(p.331-410))
Pyroprocessing of reactor fuels, 18: 33683 (TID-8540(p.411-76))
Reactor by-products, 18: 33984 (TID-8540(p.477-528))
Reactor-physics for water-moderated lattices of slightly enriched U, 18: 35113 (TID-8540(p.529-609))
Reactor technology, selected reviews—1964, 18: 35159 (TID-8540)

ARGONNE NATIONAL LAB., ILL.
Application of electron-bombardment heating for boiling liquid metals, 18: 33731 (ANL-6869)
Catalog of nuclear reactor concepts. Pt. I, Sect. I, 18: 35119 (ANL-6892)
Coherence of failure for hypothetical meltdown accidents in EBR-II-like reactor, 18: 35059 (ANL-6844)
Commercial power reactors cooled with gas or light water, 18: 35160 (TID-8540(p.1-69))
Dosimetry for radiation damage studies, 18: 34263 (ANL-6826)
Noise sources in power reactors, 18: 35155 (TID-7679(p.357-68))
Prog. rpt. on chemical engineering, 5/63–4/64, 18: 33678 (ANL-6875)
Prog. rpt. on reactor development, 5/64, 18: 35060 (ANL-6904)

ARIZONA. UNIV., TUCSON.
Improvement of BWR stability through minimization of boiling noise, 18: 35062 (EURAEC-1138)

ARMY NUCLEAR DEFENSE LAB., EDGEWOOD ARSENAL, MD.
Glass microdosimetry system, 18: 33880 (NDL-SP-6)

ATOMIC ENERGY OF CANADA LTD., CHALK RIVER, ONT.
Prog. rpt., annual, 1963–64, 18: 35241 (AECL-1972)

ATOMIC ENERGY OF CANADA LTD. WHITESHELL NUCLEAR RESEARCH ESTABLISHMENT, PINAWA, MANITOBA.
Radiation-decomposition of three low-melting organic coolants, 18: 33617 (AECL-1915)

ATOMIC POWER DEVELOPMENT ASSOCIATES, INC., DETROIT.
Loading to criticality of Fermi reactor, 18: 35139 (APDA-NTS-1)

ATOMICS INTERNATIONAL. DIV. OF NORTH AMERICAN AVIATION, INC., CANOGA PARK, CALIF.
Application of power spectra to reactor system analysis, 18: 35071 (TID-7679(p.107-33))
Fission-product release from irradiated U–ZrH SNAP fuel, 18: 34045 (NAA-SR-9673)
Nondestructive determination of U-235 content of SNAP fuel rods. II., 18: 34044 (NAA-SR-9600)
Prog. rpt. on effects of radiation on Ni–Cd battery electrodes, final, 6–12/63, 18: 34213 (AI-64-11)

Prog. rpt. on unclassified programs, 1–3/64, 18: 35247 (NAA-SR-9700)
Reactivity absorbed by Na in SRE, 18: 35149 (NAA-SR-9509)
SNAP reactor handbook—transient analysis, 18: 35201 (NAA-SR-9368)
SNAP technology handbook, 18: 35198 (NAA-SR-8617(Vol.I))
SNAP-10A structural analysis, 18: 35202 (NAA-SR-9655)
SNAP-2 structural and dynamic analysis, 18: 35199 (NAA-SR-9054)
Thermal testing of SNAP-10A prototype system (PSM-3), 18: 35200 (NAA-SR-9280)

AVCO CORP. AVCO-EVERETT RESEARCH LAB., EVERETT, MASS.
Dependence of H-I curve of Nb–Zr wire on temperature, 18: 34681 (BSD-TDR-64-87)
Hypersonic magnetohydrodynamics with or without blunt body, 18: 34272 (NASA-CR-88)

B

BABCOCK AND WILCOX, BARBERTON, OHIO.
Prog. rpt. on Na-heated steam generator, 5/64, 18: 33741 (TID-20603)

BABCOCK AND WILCOX CO. RESEARCH CENTER, ALLIANCE, OHIO.
Corrosion behavior of ATR materials of construction, 18: 34074 (IDO-24460)

BATTELLE MEMORIAL INST., COLUMBUS, OHIO.
Prog. rpt. on civilian applications, 3/64, 18: 34032 (BMI-1668(Del.))
Prog. rpt. on civilian applications, 4/64, 18: 34033 (BMI-1669(Del.))
Prog. rpt. on civilian applications, 5/64, 18: 34034 (BMI-1672(Del.))
Prog. rpt. on UN, 4–6/63, 18: 34035 (BMI-X-10053)
Refractory ceramics of interest in aerospace structural applications, 18: 34129 (RTD-TDR-64-4102(Suppl.1))

BATTELLE MEMORIAL INST. DEFENSE METALS INFORMATION CENTER, COLUMBUS, OHIO.
Dimensional instability in metals, 18: 34121 (DMIC-Memo-189)
Meeting of Refractory Composites Working Group, Fort Worth, 1/64, 18: 34037 (DMIC-Memo-192)

BERLIN. FREIE UNIVERSITÄT.
Resonator in FFAG synchrotron vacuum chamber, 18: 34371 (NP-13986)

BOEING CO., SEATTLE.
Stability of MHD channel flow, 18: 34267 (D1-82-0331)

BOSTON UNIV.
Effect of O on radiolysis of liquid methanol. III, 18: 33618 (CONF-322-14)

BRADBERRY (CARROLL E.) & ASSOCIATES, LOS ALTOS, CALIF.
Radioactive materials around cavity of underground nuclear detonation, 18: 33766 (HNS-1229-47)

BROOKHAVEN NATIONAL LAB., UPTON, N. Y.
Commercial power reactors cooled with Na, D_2O, or organic liquids, 18: 35161 (TID-8540(p.71-129))
Display oriented data simulation and analysis, 18: 34366 (BNL-8166)
High-energy separated beam for 80-in. chamber, 18: 34365 (BNL-8145)
K-meson decays, 18: 34506 (BNL-8094)
Kinetic isotope effects for some CH_3I nucleophilic substitutions, 18: 33612 (BNL-8066)
Low-frequency motions in isotactic and atactic polypropylene by neutron inelastic scattering, 18: 34265 (BNL-7320)
Mechanisms of electron transfer reactions in solution, 18: 33521 (BNL-8081)
Multiple neutron spectrometer control system, 18: 33876 (BNL-8180)
Reactor-physics for water-moderated lattices of slightly enriched U, 18: 35113 (TID-8540(p.529-609))

BUREAU OF MINES, PITTSBURGH.
Electrorefining Be, 18: 34031 (BM-RI-6489)
X-ray spectrographic analysis for trace quantities of Ta in Nb, 18: 33458 (BM-RI-6483)

C

CAEN, FRANCE. UNIVERSITE.
Mean life of unstable states of daughters of radioelements, 18: 34770 (NP-14115)

CALIFORNIA INST. OF TECH., PASADENA.
Experimental study of plasma wave resonances in hot nonuniform plasma column, 18: 34976 (NP-14195)
Prog. rpt. on behavior of aerosols, final, 7/64, 18: 33806 (NYO-10715)
Recoil electron resonance in crystals and Stokes and anti-Stokes modified lines in x-ray scattering, 18: 35242 (CALT-221-2)
Theory of plasma wave resonances in hot nonuniform plasma, 18: 34975 (NP-14194)

CALIFORNIA. UNIV., BERKELEY.
Derivation of fugacity coefficients from improved equation of state, 18: 33531 (UCRL-11369)
Fluorine-19 spin-spin coupling constants. I and II, 18: 33532 (UCRL-11395)
Martensitic transformation in alloy steel, 18: 34133 (UCRL-11388)
Particle precipitation during auroral zone phenomena, 18: 34671 (AFOSR-425)
Solubility of He in UO_2, 18: 34055 (UCRL-11043)
Superconductivity in metal carbides, 18: 34684 (UCRL-11368)

CALIFORNIA. UNIV., BERKELEY. DONNER LAB.
Cytophotometric technique and application to study of erythropoiesis, 18: 33234 (UCRL-11459)

CALIFORNIA. UNIV., BERKELEY. INST. OF ENGINEERING RESEARCH.
Effect of shock on susceptibility of magnetite grout mixture, 18: 34284 (UCRL-13088)

CALIFORNIA. UNIV., BERKELEY. LAWRENCE RADIATION LAB.
Additional properties of 959-Mev meson, 18: 34515 (UCRL-11431)
Analysis of $K^+_{\pi 2}$ decays, 18: 34519 (UCRL-11549)
Anatase-rutile transformation, 18: 35253 (UCRL-11001)
Charged-particle emission in heavy-ion interactions, 18: 34780 (UCRL-11349)
Chemistry of P_3Cl_4, 18: 35254 (UCRL-11189)
Collisional excitation and Lorentz ionization of 10-Mev H atoms, 18: 34408 (UCRL-11249)
Crystal structures of some new superconducting compounds, 18: 34283 (UCRL-11390)
Cytophotometric technique and application to study of erythropoiesis, 18: 33234 (UCRL-11459)
Derivation of fugacity coefficients from improved equation of state, 18: 33531 (UCRL-11369)
Distribution of charge-exchange and inelastic neutrons in π -p interactions, 18: 34516 (UCRL-11435)
Effect of stress on permeation through alumina membranes, 18: 34056 (UCRL-11355)
Electromagnetic levitation of metals, 18: 34057 (UCRL-11411)
Energy conversion characteristics of brushless d-c servomotor, 18: 34498 (UCRL-11334)
Extension of three-body scattering amplitude to complex values of total angular momentum, 18: 34518 (UCRL-11546)
Fluorine-19 spin-spin coupling constants. I and II, 18: 33532 (UCRL-11395)
Hydrolytic polymerization in Cr(III) solutions, 18: 35255 (UCRL-11410)
Investigation of highly populated levels of $(d_{\frac{5}{2}})^2_{\frac{5}{2}}$ and $(f_{\frac{5}{2}})^2$ configurations by (α,d) reaction, 18: 34779 (UCRL-11341)
Isomerism in At-212, 18: 34777 (UCRL-11238)
Liquid-drop theory of nuclear fission, 18: 34778 (UCRL-11338)
Lithium alloying and dislocation mechanisms in Mg, 18: 34134 (UCRL-11417)
Martensitic transformation in alloy steel, 18: 34133 (UCRL-11388)
Molecular scattering at thermal energies, 18: 34407 (UCRL-11071)
Muon-capture rate in He-3 and He-4, 18: 34776 (UCRL-11004)
Nuclear structure calculations for deformed nuclei, 18: 34781 (UCRL-11376)
Pion-nucleon scattering at 310 Mev, 18: 34512 (UCRL-11140)
Plastic deformation of MgO single crystals at elevated temperatures, 18: 34132 (UCRL-11323)
Production of $\Xi K(n)\pi$, $\Lambda K\bar{K}(n)\pi$, and $\Sigma K\bar{K}$ final states, 18: 34514 (UCRL-11430)
Recoil studies of reactions of Ir, Bi, and Pb-208 with O-16, 18: 34782 (UCRL-11563)
Search for $K^-p \rightarrow \Lambda\mu^+\mu^-$ or Λe^+e^- at 2.7 Bev, 18: 34513 (UCRL-11428)
Solubility of He in UO_2, 18: 34055 (UCRL-11043)
Stability and oscillation analysis of magnetic mirror systems, 18: 34979 (UCRL-11077)
Superconductivity in metal carbides, 18: 34684 (UCRL-11368)
Ξ^0(1530-Mev) spin and parity, 18: 34517 (UCRL-11436)

CALIFORNIA. UNIV., LIVERMORE. LAWRENCE RADIATION LAB.
Silicon nitride as high-temperature radome material, 18: 34054 (UCRL-7795)
Unsolved problems of explosive sensitivity, 18: 35252 (UCRL-7898)

CAMBRIDGE ELECTRON ACCELERATOR, MASS.
Cambridge electron accelerator, 18: 34367 (CEAL-1000)

CANADA. SUFFIELD EXPERIMENTAL STATION, RALSTON, ALBERTA.
Explosion of 20-ton TNT charge, 18: 34278 (NP-14174(Vol.1))

CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC., PARR, S. C.
Prog. rpt. on CVTR operation, 4/1–6/15/64, 18: 35140 (CVNA-207)
Vapor container leak rate test on CVTR, 18: 35141 (CVNA-208)

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Neutron flux distributions in water system with internal cavity, 18: 34731 (NASA-CR-54110)

CENTRO INFORMAZIONI STUDI ESPERIENZE, MILAN.
Liquid volume fraction in two-phase adiabatic flow, 18: 33732 (EURAEC-1086)

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Preparation of active UO_2, 18: 33533 (UJV-725/63)
Radiation effects on ketone extraction. II., 18: 33621 (UJV-977/64)
CHALMERS TEKNISKA HÖGSKOLA, GÖTEBORG.
Dynamic wave propagation in ionized media. XI., 18: 34967 (AFCRL-63-786)
CHILDREN'S CANCER RESEARCH FOUNDATION, BOSTON.
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CLUJ. UNIVERSITATEA "BABEŞ-BOLYAI."
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COLUMBIA UNIV., NEW YORK.
Kinetic-theoretic description of formation of shock wave, 18: 34279 (NP-14186)
Low-frequency motions in isotactic and atactic polypropylene by neutron inelastic scattering, 18: 34265 (BNL-7320)
Prog. rpt. on nuclear physics, 1/63–1/64, 18: 34752 (CU(PNPL)-234)
Reactor impulse response using random source excitation and cross correlation, 18: 35075 (TID-7679(p.203-18))
COMBUSTION ENGINEERING, INC., WINDSOR, CONN.
Prog. rpt. on burnable poison additions to UO_2, 4–6/64, 18: 35126 (CEND-3107-216)
COMPAGNIE FRANÇAISE THOMSON-HOUSTON, PARIS.
Nuclear vapotron, 18: 34090 (EURAEC-1015)
COMPAGNIE PECHINEY, PARIS.
Prog. rpt. on corrosion tests in steam, 1–3/64, 18: 34060 (EURAEC-1062)
CONCORDIA COLL., MOORHEAD, MINN.
Prog. rpt. on distribution of electrons from gases ionized by proton impact, 4–7/64, 18: 34404 (COO-1277-5)

D

DAVID TAYLOR MODEL BASIN, CARDEROCK, MD.
Modified P_3 approximations to neutron transport equation, 18: 34728 (DTMB-1814)
DENMARK. ATOMENERGIKOMMISSIONEN. FORSØGSINSTITUT, RISØ.
Heavy-water lattice calculations, 18: 35112 (RISÖ-81)
Personnel dosimetry practice, 18: 33807 (RISÖ-78)
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Report number series, 18: 35251 (TID-85(3rd Rev.))
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Prog. rpt. on D_2O-moderated power reactors, 5–6/64, 18: 35143 (DP-915)
DU PONT DE NEMOURS (E. I.) & CO. SAVANNAH RIVER LAB., AIKEN, S. C.
Determination of metallic impurities in H_2O by atomic absorption spectrometry, 18: 33461 (DP-879)
Determination of U isotopes in irradiated Th, 18: 33462 (DP-883)
Electronic trip device, 18: 33826 (DP-897)
Prog. rpt. on HWR, 6/64, 18: 35061 (DPST-64-83-6)
Walk-through hand and shoe monitor for β-γ contamination, 18: 33877 (DP-893)
DUKE UNIV., DURHAM, N. C.
NMR in solid H_2 and D_2 under high pressure, 18: 34260 (AD-601933)
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Prog. rpt. on PWR operations, 5/64, 18: 35142 (DLCS-5000564)

E

EINDHOVEN, NETHERLANDS. TECHNISCHE HOGESCHOOL.
Prog. rpt. on steady-state and dynamic behavior of BWR, 1–4/64, 18: 33733 (EURAEC-1127)
ESSO RESEARCH AND ENGINEERING CO., LINDEN, N. J.
Low-frequency motions in isotactic and atactic polypropylene by neutron inelastic scattering, 18: 34265 (BNL-7320)
EUROPEAN ATOMIC ENERGY COMMUNITY.
Level indication measurements, wetting, and bubble indication of liquid Na in stainless steel container, 18: 33827 (EUR-1823.d)
Observations on annealed- and ion-bombarded SAP foils, 18: 34038 (EUR-1833.e)
Portable plant for decontamination of buildings and equipment, 18: 33800 (EUR-1821.f)
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Observations on annealed- and ion-bombarded SAP foils, 18: 34038 (EUR-1833.e)
Portable plant for decontamination of buildings and equipment, 18: 33800 (EUR-1821.f)
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Coulomb scattering in focusing media—FORTRAN programs, 18: 34368 (CERN-64-29)
SU, model for strong interaction symmetry and its breaking. II., 18: 34510 (NP-14146)

F

FIAT. SEZIONE ENERGIA NUCLEARE, TURIN.
Fission gas release from UO_2, 18: 34214 (EURAEC-1126)
FLORIDA STATE UNIV., TALLAHASSEE.
Coriolis anti-pairing and blocking effects in deformed even-even nuclei, 18: 34775 (TID-20875)
FLORIDA. UNIV., GAINESVILLE.
Digital reduction of data in noise analysis, 18: 35077 (TID-7679 (p.301-5))
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Application of power spectra to reactor system analysis, 18: 35071 (TID-7679(p.107-33))
Correlation function analysis of systems obeying linear differential equations, 18: 35078 (TID-7679(p.321-9))
Digital reduction of data in noise analysis, 18: 35077 (TID-7679(p.301-5))
Harmonic analysis of instantaneous counting rate of periodically sampled flow of pulses, 18: 35079 (TID-7679(p.331-4))
Negative reactivity measurement by neutron fluctuation analysis, 18: 35074 (TID-7679(p.171-81))
Noise analysis of reactor systems, 18: 35073 (TID-7679(p.155-69))
Noise measurements in Dounreay Fast Reactor, 18: 35158 (TID-7679 (p.469-500))
Noise sources in power reactors, 18: 35155 (TID-7679(p.357-68))
Reactivity measurements using source excitation and correlation techniques, 18: 35076 (TID-7679(p.219-28))
Reactor impulse response using random source excitation and cross correlation, 18: 35075 (TID-7679(p.203-18))
Reactor noise measurements on Saxton reactor, 18: 35156 (TID-7679 (p.427-47))
Shutdown reactivity measurements using noise techniques, 18: 35072 (TID-7679(p.135-54))
Statistical uncertainties in pulsed neutron and excursion experiments, 18: 35080 (TID-7679(p.347-55))
Stochastic models for fission reactors, 18: 35070 (TID-7679(p.29-59))
FORDHAM UNIV., NEW YORK.
Prog. rpt. on reactions produced when antiprotons annihilate on protons, final, 18: 34511 (NYO-2584-1)
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Analysis of H_2O–D_2O mixtures, 18: 33460 (CEA-R-2440)
Bibliography on radiation effects on corrosion, 18: 34036 (CEA-Bib-16)
Chlorine trifluoride, 18: 33522 (CEA-2360)
Correlation function analysis of systems obeying linear differential equations, 18: 35078 (TID-7679(p.321-9))
Criticality experiments with annular cylinders containing Pu solutions, 18: 34494 (CEA-R-2495)
Differential systems of flux and concentrations of mixture in separation by plant stage, 18: 34004 (CEA-R-2337)
Harmonic analysis of instantaneous counting rate of periodically sampled flow of pulses, 18: 35079 (TID-7679(p.331-4))
Luminous sources for U isotope measurements by emission spectrometry, 18: 33459 (CEA-R-2428)
Mean life of unstable states of daughters of radioelements, 18: 34770 (NP-14115)
Neutron thermalization in absorbing infinite and homogeneous media, 18: 34727 (CEA-R-2368)

Reactivity measurements using source excitation and correlation techniques, 18: 35076 (TID-7679(p.219-28))
Trapping of I by active charcoals, 18: 33808 (AEC-tr-6459)

FRANCE. SERVICE CENTRAL DE PROTECTION CONTRE LES RAYONNEMENTS IONISANTS, PARIS.
High-activity dusts isolated in fallout, 18: 33770 (SCPRI(S)-99)

FRANKLIN INST., PHILADELPHIA.
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FREIBURG I. B. UNIVERSITAT.
Coriolis anti-pairing and blocking effects in deformed even-even nuclei, 18: 34775 (TID-20875)

G

GARRETT CORP. AIRESEARCH MFG. DIV. OF ARIZONA, PHOENIX.
Apparatus to measure biaxial creep of materials in Li, 18: 34030 (APL-TDR-64-73)

GAUTNEY & JONES, CONSULTING ENGINEERS, WASHINGTON, D. C.
Transmitters and receivers for fallout shelter, 18: 33840 (TGGM-642)

GENERAL ATOMIC DIV., GENERAL DYNAMICS CORP., SAN DIEGO, CALIF.
Analysis of pulsed, multiplying systems, 18: 34495 (GA-5404)
Prog. rpt. on mechanical properties of reactor materials, 1/64, 18: 34039 (GA-5340)
Prog. rpt. on reactor materials, 10/62–9/63, 18: 34122 (GA-4900)

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Prog. rpt. on high-temperature materials, 3/15–5/15/64, 18: 34040 (GEMP-36A)

GENERAL ELECTRIC CO. ATOMIC POWER EQUIPMENT DEPT., SAN JOSE, CALIF.
Prog. rpt. on fast ceramic reactor program, 1–3/64, 18: 35146 (GEAP-4601)
Prog. rpt. on Garigliano reactor, 7/64, 18: 35147 (GEAP-4645)
Prog. rpt. on high-performance UO_2 program, 4–6/64, 18: 35127 (GEAP-3771-13)
Prog. rpt. on nuclear superheat fuel, 12/63–2/64, 18: 35145 (GEAP-4566)
Prog. rpt. on sodium mass transfer, 1–6/63, XI., 18: 34073 (GEAP-4438)
Prog. rpt. on transition boiling heat transfer, 4–6/64, 18: 33734 (GEAP-4646)
Tests on EVESR MK I fuel bundle, 18: 35144 (GEAP-4560)
Uranium dioxide thermal conductivity from irradiations with central melting, 18: 34215 (GEAP-4624)

GENERAL ELECTRIC CO. ATOMIC PRODUCTS DIV., CINCINNATI.
In-core instrumentation, 18: 35089 (TID-8540(p.177-211))

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Corrosion isotopes in half-plant low alum feed H_2O treatment, 18: 35193 (HW-78431)
Corrosion isotopes in half-plant low pH coolant, 18: 35194 (HW-78964)
Fission products, 18: 33983 (HW-SA-3080(Rev.))
Fracture stresses of UO_2–W cermets, 18: 34124 (HW-79676)
GANDS—program to derive Westcott parameters, 18: 34015 (HW-81117 (Rev.1))
Ground-level air exposures resulting from emissions from stacks at Hanford, 18: 33801 (HW-80204)
In-pile dosimetry techniques, 18: 33879 (HW-SA-3585)
Integrator for neutron dose-rate meter, 18: 33878 (HW-81774)
Mobile whole-body counter, 18: 33802 (HW-80216)
Multicomponent tubular UO_2 fuel element irradiations, 18: 35129 (HW-80291)
NPR steam generator tubing burst tests, 18: 35195 (HW-82233)
Preparation of graphites for irradiation, 18: 34041 (HW-80752)
Prog. rpt. on fixation of radioactive residues, 1–3/64, 18: 35234 (HW-81862)
Reaction of nuclear graphite with CO_2, 18: 33525 (HW-74663)
Recent PRTR kinetics tests using random signals, 18: 35111 (HW-81211)
Thermal stress analysis of tube joint for "N" reactor, 18: 33694 (HW-76850)
Valve for control of streams of powdered solids, 18: 33712 (HW-53440)

GENERAL ELECTRIC CO. MISSILE AND SPACE DIV., CINCINNATI.
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Radiation effects on living trees, 18: 33282 (TID-20876)

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H

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Ion engine ground testing techniques, 18: 34261 (AEDC-TDR-64-127)

HYDRONAUTICS, INC., LAUREL, MD.
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I

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Removal of Co and Cr from citrate-containing radioactive liquid waste, 18: 35235 (IDO-12036)

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Prog. rpt. on magnetic properties of insulators, 2/16–5/15/64, 18: 35243 (IITRI-1184-13)

ILLINOIS. UNIV., URBANA.
Crossed-field charged particle delay lines, 18: 34277 (NP-14134)
Effects of electron-surface interaction in ionization gages, 18: 33759 (AD-427830)
Radiation effects in semiconductors, 18: 34216 (NASA-TN-D-2364)

INSTITUT ZA NUKLEARNE NAUKE "BORIS KIDRIC," BELGRADE.
Neutron diffractometer, 18: 33881 (NP-14131)
Sintering process for UO_2 according to Pines theory, 18: 34048 (NP-14124)

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA.
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IAEA research contracts, fourth annual rpt., 18: 35250 (STI/DOC/10/28)
Radioactive waste management and environmental research, 18: 35238 (STI/DOC/10/28(p.9-20))
Radiobiology, 18: 33278 (STI/DOC/10/28(p.39-66))
Radioisotope applications in agriculture, 18: 33213 (STI/DOC/10/28 (p.79-103))
Radioisotope applications in medicine, 18: 33214 (STI/DOC/10-28 (p.105-11))
Safeguards methods, 18: 35065 (STI/DOC/10/28(p.67-71))
Studies involving reactors, 18: 35066 (STI/DOC/10/28(p.73-7))

ISRAEL. ATOMIC ENERGY COMMISSION, REHOVOTH.
Activities of Chemistry Division, 18: 33447 (IA-893)
Chemistry of Np(III), Pu(III), and Am(III) in halide solutions, 18: 33526 (IA-924)
Nuclear education and training at Israel Research Reactor, 18: 35219 (IA-894)
Nuclear power program in small countries, 18: 35148 (IA-891)
Reactor physics research at Israel Research Reactor, 18: 35218 (IA-892)

ITALY. COMITATO NAZIONALE PER L'ENERGIA NUCLEARE, ROME.
Automatic counting scaler, 18: 33884 (RT/EL(64)-7)

Data recording system for physics experiments, 18: 33837 (RT/EL(64)-8)
Influence of rate cooling from γ phase on U alloys, 18: 34127 (RT/MET(64)-2)
Mössbauer effect analyzer, 18: 33834 (RT/EL(63)-15)
Transistor as logarithmic element, 18: 33836 (RT/EL(64)-5)
Tunnel-diode fast discriminator, 18: 33835 (RT/EL(64)-3)
Void fraction in experimental loops, 18: 33739 (RT/ING(64)-5)

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JAPAN ATOMIC ENERGY RESEARCH INST., TOKYO.
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Chemistry, 18: 33449 (NIRS-2(p.15-19))
Cytology and morphology, 18: 33271 (NIRS-2(p.26-31))
Environmental studies, 18: 33805 (NIRS-2(p.57-67))
Genetics, 18: 33273 (NIRS-2(p.42-8))
Medical studies, 18: 33231 (NIRS-2(p.49-56))
Physics, 18: 34274 (NIRS-2(p.3-15))
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Angular distribution of products of multinucleon transfer reactions, 18: 34762 (JINR-P-1675)
Attempt to detect Ne-16 two-proton decay, 18: 34765 (JINR-P-1679)
Boundary value problem for equations of mathematical physics, 18: 34269 (JINR-P-1682)
Elastic p-p scattering at 8.3 Bev, 18: 34508 (JINR-P-1674)
Electromagnetic transitions from collective to ground states of even-even deformed nuclei, 18: 34761 (JINR-E-1703)
Excited states with $K\pi = 2+$ of even-even deformed nuclei, 18: 34760 (JINR-E-1696)
Focusing properties of sextupole magnet, 18: 34369 (JINR-P-1681)
Formation of fissioning isomer in capture of neutrons by Am, 18: 34759 (JINR-D-1693)
Interaction of cosmic particles with nuclei, 18: 34764 (JINR-P-1678)
Proton decay of nuclei with $Z > 50$, 18: 34767 (JINR-P-1706)
Relativistic corrections to s and p waves of π-N scattering, 18: 34507 (JINR-E-1686)
Scattering length and cross section for neutron radiative capture, 18: 34762 (JINR-P-1671)

K

KERNFORSCHUNGSANLAGE, JÜLICH, GERMANY.
High-level dose effects in silver-activated metaphosphate glasses, 18: 33891 (ORNL-tr-216)
KERNFORSCHUNGSZENTRUM, KARLSRUHE, GERMANY.
Two- and many-component systems with Pu. II., 18: 34125 (KFK-220)
KERNREAKTOR BAU- UND BETRIEBS-GESELLSCHAFT M.B.H., KARLSRUHE, GERMANY.
Effect of two temperature coefficients of reactivity, which result from segregation of fuel, 18: 35114 (ORNL-tr-263)
KNOLLS ATOMIC POWER LAB., SCHENECTADY, N. Y.
STAT-3: Interpretive program for logical operations, 18: 35244 (KAPL-M-6165)

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Prog. rpt. on superconductive effects in films, 7/15–10/15/63, 18: 33824 (AD-428788)
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LONDON. UNIV. QUEEN MARY COLL.
Stochastic models for fission reactors, 18: 35070 (TID-7679(p.29-59))
LOS ALAMOS SCIENTIFIC LAB., N. MEX.
Automatic lens design by statistical analysis, 18: 35245 (LADC-6205)
Determining release from point source, 18: 33803 (LA-3094)
Large volume operational room inerting, 18: 33804 (LADC-6432)
Time-of-flight measurements made with neutrons from nuclear explosions in space, 18: 34751 (CONF-481-71)
STATION, JACKASS FLATS, NEV.
Large volume operational room inerting, 18: 33804 (LADC-6432)
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Radiation effects on telemetry, 18: 33839 (RTD-TDR-63-4287(Vol.II))
Radiation effects on telemetry, 18: 33838 (RTD-TDR-63-4287(Vol.I))
LYON. UNIVERSITÉ.
Analyticity of S matrix with regard to variable angular moment, 18: 34637 (NP-14076)
Production of secondary particles in interactions of elementary particles, 18: 34509 (NP-14086)
Reactions (n,α) by direct interaction model, 18: 34769 (NP-14085)

M

MARQUARDT CORP., VAN NUYS, CALIF.
Radiation-resistant magnetic amplifier controls, 18: 33825 (AD-435095)
MARYLAND. UNIV., COLLEGE PARK.
Antisymmetrization of unified nuclear reaction theory. II., 18: 34773 (NP-14190)
Coriolis anti-pairing and blocking effects in deformed even-even nuclei, 18: 34775 (TID-20875)
Survey of magnetofluid dynamics, 18: 34264 (ARL-63-175(Pt.II))
MASSACHUSETTS. GENERAL HOSPITAL, BOSTON.
Use of neutrons in treatment of neoplasms, 18: 33431 (TID-20856)
MASSACHUSETTS INST. OF TECH., CAMBRIDGE.
Intermediate resonances and doorway states, 18: 34768 (MIT-2098-61)
On-site resistivity and self-potential measurements, 18: 33780 (NP-14145)
Pyrolysis and radiolysis in degradation of terphenyls, 18: 33619 (MITNE-48)
Thermal contact resistance, 18: 33735 (MIT-2079-2)
METALS AND CONTROLS INC., ATTLEBORO, MASS.
Prog. rpt. on coatings for Nb and Mo alloys, 3–4/64, 18: 34029 (AD-601740)
MICHIGAN. UNIV., ANN ARBOR.
Discrimination of seismic signals from earthquakes and explosions, 18: 33765 (AD-437784)
Prog. rpt. on microwave plasma components study, 18: 34977 (RADC-TDR-64-94)
MILLETRON, INC., IRWIN, PENNA.
Shutdown reactivity measurements using noise techniques, 18: 35072 (TID-7679(p.135-54))
MINNESOTA. UNIV., MINNEAPOLIS.
Hydrogen isotopes produced in solar flares, 18: 34382 (NP-14141)
MOUND LAB., MIAMISBURG, OHIO.
Prog. rpt., 4/64, 18: 35246 (MLM-1196)

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Planetary physics. V., 18: 34405 (NASA-CR-87)
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND.
Fused fluoride coatings as solid lubricants, 18: 33695 (NASA-TN-D-2348)
Heavy-molecule propellants in electron-bombardment thruster, 18: 33696 (NASA-TN-D-2401)
Magnetic field from finite thin cone, 18: 34273 (NASA-TN-D-2400)
Nucleate boiling under normal and reduced gravity conditions, 18: 33736 (NASA-TN-D-2299)
NATIONAL BUREAU OF STANDARDS, BOULDER, COLO.
Prog. rpt. on cryogenic aspects of project Sherwood, 3–6/64, 18: 34682 (NBS-8407)
NATIONAL LEAD CO. OF OHIO, CINCINNATI.
Standards for metallographic evaluations of U, 18: 34047 (NLCO-910)
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Report of committee on Be metallurgy, 6/64, 18: 34042 (MAB-199-M(1))
NAVAL AIR MATERIAL CENTER, PHILADELPHIA.
Size effect in Be wire, 18: 34126 (NAMC-AML-1550)
NAVAL ORDNANCE LAB., WHITE OAK, SILVER SPRING, MD.
Knock-off tube as quick pressure release mechanism, 18: 33829 (NOLTR-63-134)
NAVAL RADIOLOGICAL DEFENSE LAB., SAN FRANCISCO.
Determination of Ce-141 and Ce-144 in fission-product mixtures, 18: 33465 (USNRDL-TR-756)
Solute distribution in Na_2O–B_2O_3–NaCl system. II, 18: 33534 (USNRDL-TR-760)
NEW MEXICO. UNIV., ALBUQUERQUE.
Temperature distribution and thermal stresses in radiation-cooled circular cylinders, 18: 33740 (SC-DC-64-891)
NEW MEXICO. UNIV., ALBUQUERQUE. ENGINEERING EXPERIMENT STATION.

Temperature distribution and thermal stresses in radiation-cooled circular cylinders, 18: 33740 (SC-DC-64-891)

NORTH AMERICAN AVIATION, INC., DOWNEY, CALIF.
Properties of coated refractory and superalloy sheet, 18: 34128 (RTD-TDR-63-4068)

NORTHROP CORP. NORTHROP SPACE LABS., HAWTHORNE, CALIF.
Computer analysis of radiation shielding, 18: 35048 (AMRL-TDR-64-11)

NORWAY. INSTITUTT FOR ATOMENERGI, KJELLER.
BIGG-I—multigroup neutron spectrum and criticality code, 18: 34730 (KR-77)
Steel irradiation program, 18: 34219 (RCN-26)

NORWAY. INSTITUTT FOR ATOMENERGI. OECD HALDEN REAKTOR PROSJEKT.
Reactor noise experiments on Halden BWR, 18: 35157 (TID-7679(p.449-68))

NUCLEAR MATERIALS AND EQUIPMENT CORP., APOLLO, PENNA.
Prog. rpt. on Pu-bearing fuel materials, 7–9/63, 18: 34049 (NUMEC-P-106)

O

OAK RIDGE NATIONAL LAB., TENN.
Applications of distorted wave approximation for direct nuclear reactions, 18: 34774 (ORNL-P-144)
Characterization of spheroidal UO_2 particles and fabrication variables for fuel plates, 18: 34088 (ORNL-3645)
Combustion of graphite–U fuels, 18: 33682 (ORNL-P-200)
Conversion of high-level radioactive waste solutions to glassy solids, 18: 35237 (ORNL-3629)
Developments in d-c polarography, 18: 33452 (ORNL-P-145)
Effect of scale-up on fuel cycle costs, 18: 35151 (ORNL-TM-564)
Energy response of the ORNL Cutie Pie Chamber to photon radiation, 18: 33883 (ORNL-TM-897)
Fabrication of U_3O_8–Al composite fuel plates, 18: 34087 (ORNL-3644)
Fabrication of vertical-orifice Teflon capillary of Teflon dropping-Hg electrode, 18: 33451 (ORNL-3654)
Fixation of high-level radioactive wastes in glassy solids, 18: 35236 (ORNL-3612)
Gas-phase reduction of UCl_4 to UCl_3 with CO, 18: 33530 (ORNL-TM-829)
High-temperature high-vacuum thermocouple drift tests, 18: 33833 (ORNL-TM-883)
In-reactor stress-rupture properties of 20 Cr–25 Ni, 18: 34218 (ORNL-TM-881)
Materials studies, 18: 34050 (ORNL-3626(p.59-164))
MSRE design, engineering, and component development, 18: 35221 (ORNL-3626(p.3-58))
Negative reactivity measurement by neutron fluctuation analysis, 18: 35074 (TID-7679(p.171-81))
Production of tritium by contained nuclear explosions in salt, 18: 33529 (ORNL-3334(Pt.II))
Prog. rpt. of Isotopes Division, 1–3/60, 18: 34006 (ORNL-TM-889)
Prog. rpt. of Isotopes Division, 1–3/61, 18: 34007 (ORNL-TM-890)
Prog. rpt. on isotopic separations, 1–3/64, 18: 34005 (ORNL-TM-879)
Prog. rpt. on molten-salt reactor program, semiannual, 1/64, 18: 35064 (ORNL-3626)
Reactor by-products, 18: 33984 (TID-8540(p.477-528))
Reactor safety analysis, MSRE design, 18: 35152 (ORNL-TM-732)
Studies of boiling burnout, 18: 33737 (ORNL-P-18)
Subcooled swirl-flow boiling and burnout, 18: 33738 (ORNL-TM-894)
Vacuum distillation of Mg metal, 18: 34051 (ORNL-TM-749)
Water-loss test at the LITR, 18: 35222 (ORNL-TM-632)

OXFORD UNIV.
Infrared absorption of H^- and D^- ions in CaF_2, 18: 34262 (AFCRL-64-284)

P

PARAMETRICS, INC., WALTHAM, MASS.
Prog. rpt. on development of Kr-85 as universal tracer, 11/63–1/64, 18: 33450 (NYO-2757-4)

PARIS. UNIVERSITE.
Differential systems of flux and concentrations of mixture in separation by plant stage, 18: 34004 (CEA-R-2337)
Ionization produced in gas by beam of relativistic electrons, 18: 34270 (LAL-1093)
Neutron thermalization in absorbing infinite and homogeneous media, 18: 34727 (CEA-R-2368)
Nuclear structure calculations for deformed nuclei, 18: 34781 (UCRL-11376)

PARIS. UNIVERSITÉ, ORSAY.
Antisymmetrization of unified nuclear reaction theory. II., 18: 34773 (NP-14190)
Collective description of classical plasmas, 18: 34972 (ARL-64-140)
Prog. rpt. on density effect in solids and gases, final, 18: 34258 (AD-417250)
Prog. rpt., 10/63–4/64, 18: 34271 (LAL-1107)
Storage rings for electrons, 18: 34370 (LAL-1110)

PAVIA, ITALY. UNIVERSITÀ. ISTITUTO DI GENETICA.
Prog. rpt. on mutability of polygenes, 4/64, 18: 33279 (TID-20823)

PFAUDLER CO., ROCHESTER, N. Y.
Applying protective coatings to Nb alloys, 18: 34052 (RTD-TDR-63-4063)

PHILLIPS PETROLEUM CO. ATOMIC ENERGY DIV., IDAHO FALLS, IDAHO.
Adsorption of young fission products on various surfaces, 18: 33448 (IDO-14644)
Scintillation spectrometry γ-ray spectrum catalog, 18: 34755 (IDO-16880-1)
Scintillation spectrometry gamma-ray spectrum catalog, 18: 34756 (IDO-16880-2)
Spert I destructive test program on Al, plate-type, water-moderated reactor, 18: 35220 (IDO-16883)
TOPIC—FORTRAN program for calculating transport of particles in cylinders, 18: 34729 (IDO-16968)

PHYSICS, ENGINEERING, CHEMISTRY CORP., BOULDER, COLO.
Dynamics of ionized media, 18: 34971 (ARL-64-85)

PICATINNY ARSENAL, DOVER, N. J.
Low-frequency motions in isotactic and atactic polypropylene by neutron inelastic scattering, 18: 34265 (BNL-7320)

PITTSBURGH. UNIV.
Recombination of molecular positive ions with electrons, 18: 34259 (AD-434907)

PRATT AND WHITNEY AIRCRAFT DIV., UNITED AIRCRAFT CORP. CONNECTICUT AIRCRAFT NUCLEAR ENGINE LAB., MIDDLETOWN.
Thermal conductivity of UC, 18: 34120 (CNLM-5621)
Thermal decomposition of UC, 18: 33523 (CNLM-5619)
Thermal decomposition of UN, 18: 33524 (CNLM-5620)

PRINCETON UNIV., N. J.
Prog. rpt. on lattice and electronic defects in solids, final, 6/64, 18: 34280 (NYO-2680-1)

R

RADIO CORP. OF AMERICA. INDUSTRIAL TUBE AND SEMICONDUCTOR DIV., LANCASTER, PENNA.
Prog. rpt. on 5-inch high-speed photomultiplier, final, 6/63–6/64, 18: 33882 (NYO-3190-1)

RAND CORP., SANTA MONICA, CALIF.
Potential energy curves for N_2, NO, and O_2, 18: 34281 (RM-4034-PR)

REACTIVE METALS, INC., SEYMOUR, CONN.
Prog. rpt. on U fabrication, 1–4/64, 18: 34085 (BRB-81)

REACTOR CENTRUM NEDERLAND, PETTEN.
Steel irradiation program, 18: 34219 (RCN-26)

RENSSELAER POLYTECHNIC INST., TROY, N. Y.
Prog. rpt. on metallurgical studies of Zr and Th, 8/63–7/64, 18: 34053 (TID-20862)

ROSCOE B. JACKSON MEMORIAL LAB., BAR HARBOR, ME.
Prog. rpt. on population genetics of mice under irradiation, 7/63–6/64, 18: 33281 (TID-20844)

S

SANDIA CORP., ALBUQUERQUE, N. MEX.
Full-scale submarine test facility, 18: 33709 (SC-TM-64-636)
Receiving characteristics of two-wire lines excited by uniform and non-uniform electric fields, 18: 35249 (SC-R-64-164)

SAVANNAH RIVER OPERATIONS OFFICE, AEC.
Prog. rpt. on D_2O power reactor program, 6/64, 18: 35153 (SRO-103)

SHARP (GEORGE G.) INC., NEW YORK.
Role of nuclear power in merchant marine, 18: 35203 (NP-14139)

SLOAN-KETTERING INST. FOR CANCER RESEARCH, NEW YORK.
Prog. rpt. on effects of x rays on mice bones, 5/63–5/64, 18: 33276 (NYO-910-7)
Prog. rpt. on free radical production and secondary electron spectra, 5/63–5/64, 18: 33274 (NYO-910-1)
Prog. rpt. on kinetic state of Ca in bone lesions, 6/63–5/64, 18: 33233 (NYO-910-9)
Prog. rpt. on metabolic studies with Ca-47, 5/63–5/64, 18: 33232 (NYO-910-3)
Prog. rpt. on radiation mechanisms in biological systems, 5/63–5/64, 18: 33275 (NYO-910-2)

SOCIÉTÉ ALSTHOM, PARIS.
Nuclear vapotron, 18: 34090 (EURAEC-1015)

SOUDOMETAL, S. A., BRUSSELS.

Prog. rpt. on welding of thick steels, 10–12/63, 18: 34089 (EURAEC-915)

SOUTHWEST RESEARCH INST., SAN ANTONIO.
Prog. rpt. on Elk River reactor pressure vessel, 4–5/64, 18: 35154 (SWRI-1228-28)
Prog. rpt. on liquid-metal lubricated journal bearings, 4–6/64, 18: 33697 (SWRI-1228-26)

SPAIN. JUNTA DE ENERGIA NUCLEAR, MADRID.
Interactions of low-energy deuterons with V-51, 18: 34758 (JEN-130-DF/I-41)
Solvent-extraction systems applied to U analysis. I., 18: 33679 (JEN-136-DQ/I-40)
Solvent-extraction applied to analysis of U. II., 18: 33680 (JEN-137-DQ/I-41)
Solvent-extraction applied to analysis of U. III., 18: 33681 (JEN-138-DQ/I-42)
Spectrophotometric determination of U, 18: 33463 (JEN-139-DQ/I-43)
"Syrio" program for calculation of matrix inverse, 18: 34016 (JEN-122-DF/I-38)

STANFORD RESEARCH INST., MENLO PARK, CALIF.
Prog. rpt. on sorption of gases on metal surfaces in vacuum, 2/15–5/15/64, 18: 34282 (TID-20837)

STANFORD UNIV., CALIF.
Prog. rpt. on failure of klystron windows, 18: 33841 (TID-20833)
Prog. rpt. on failure of klystron windows, 18: 33842 (TID-20834)
Prog. rpt. on two-mile accelerator, 1–3/64, 18: 34372 (SLAC-30)

STEVENS INST. OF TECH., HOBOKEN, N. J.
Prog. rpt. on cusped containment geometries, annual, 1963–64, 18: 34978 (SIT-P126)

SYDNEY. UNIV.
Damping of transverse plasma oscillations at ion cyclotron resonance, 18: 34974 (NP-14153)

SYRACUSE UNIV., N. Y.
Phase equilibria and specific volumes of liquid metals, 18: 34131 (TID-20849)
Prog. rpt. on biosynthesis of proteins by living cells, 3/63–6/64, 18: 33212 (NYO-2570-1)

T

TEXAS. AGRICULTURAL AND MECHANICAL UNIV., COLLEGE STATION.
Automatic systems for biologic nuclear activation analyses, 18: 33464 (NASA-CR-52997)

THOMPSON RAMO WOOLDRIDGE INC. TRW SPACE TECHNOLOGY LABS., REDONDO BEACH, CALIF.
Prog. rpt. on kinetic studies of heterogeneous water reactors, 1–3/64, 18: 35067 (STL-372-3)
Prog. rpt. on kinetic studies of heterogeneous water reactors, annual, 1963, 18: 35068 (STL-6312)
Prog. rpt. on kinetic studies of heterogeneous water reactors, 6/64, 18: 35223 (STL-372-6)

TOKYO UNIV.
Acoustic attenuation studies of frictional force on fast moving dislocation, 18: 34276 (NP-14129)
Noise analysis of reactor systems, 18: 35073 (TID-7679(p.155-69))
Nuclear magnetic resonance in nickel fluosilicate, 18: 34275 (NP-14114)
Numerical differential cross sections of $Ca^{40}(p,d)Ca^{39}$ at 55 Mev, 18: 34757 (INSJ-72)

TRG, INC., MELVILLE, N. Y.
TRG-SGD—Monte Carlo program to calculate secondary γ dose from nuclear weapon detonation, 18: 34285 (WL-TDR-64-46(Vol.I))

U

U.S.S.R. SOVET MINISTROV. GOSUDARSTVENNYI KOMITET PO ISPOL'ZOVANIYU ATOMNOĬ ENERGII.
Strontium-90 content in fresh water reservoirs, 18: 33769 (NP-14091)
Thermodynamic calculations of reaction of Na and H_2O, 18: 33528 (NP-14080)

UNION CARBIDE CORP. CARBON PRODUCTS DIV., PARMA, OHIO.
High-temperature protective coatings for graphite, 18: 34043 (ML-TDR-64-173(Pt.I))
Preparation of graphites for irradiation, 18: 34041 (HW-80752)

UNION CARBIDE CORP. STELLITE DIV., KOKOMO, IND.
Prog. rpt. on Nb(Cb-752) alloy, 7–11/63, 18: 34025 (AD-428036)

UNITED KINGDOM ATOMIC ENERGY AUTHORITY. INDUSTRIAL GROUP. DOUNREAY EXPERIMENTAL REACTOR ESTABLISHMENT, CAITHNESS, SCOTLAND.
Noise measurements in Dounreay Fast Reactor, 18: 35158 (TID-7679 (p.469-500))

UNITED KINGDOM ATOMIC ENERGY AUTHORITY. REACTOR GROUP, CULCHETH, LANCS, ENGLAND.
Corrosion treatment for cooling water circuits, 18: 35063 (IG-Report-52)

UNITED KINGDOM ATOMIC ENERGY AUTHORITY. RESEARCH GROUP. ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, BERKS, ENGLAND.
Heat transfer to high-pressure steam and water in annulus. VI., 18: 33730 (AERE-R-4352)
Heater for graphite channel oxidation experiment, 18: 33711 (AERE-M-1373)
Metallic fuels, 18: 34130 (TID-8540(p.331-410))

UNITED KINGDOM ATOMIC ENERGY AUTHORITY. RESEARCH GROUP. CULHAM LAB., CULHAM, ABINGDON, BERKS, ENGLAND.
Computer programs for numerical study of magnetic fields, 18: 34266 (CLM-R-31)

UNITED KINGDOM ATOMIC ENERGY AUTHORITY. WEAPONS GROUP. ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKS, ENGLAND.
Influence of O on U–H_2O reaction. III., 18: 34072 (AWRE-O-40/64)
Neutron cross sections of U-236 in range 1 kev to 15 Mev, 18: 34750 (AWRE-O-30/64)
Neutron surface multiplications of transport containers, 18: 34726 (AWRE-O-21/64)
VLF phase anomalies associated with nuclear explosions, 18: 34250 (AWRE-O-35/64)

UNITED STATES–EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.
Fission gas release from UO_2, 18: 34214 (EURAEC-1126)
Improvement of BWR stability through minimization of boiling noise, 18: 35062 (EURAEC-1138)
Liquid volume fraction in two-phase adiabatic flow, 18: 33732 (EURAEC-1086)
Nuclear vapotron, 18: 34090 (EURAEC-1015)
Prog. rpt. on burnable poison additions to UO_2, 4–6/64, 18: 35126 (CEND-3107-216)
Prog. rpt. on corrosion tests in steam, 1–3/64, 18: 34060 (EURAEC-1062)
Prog. rpt. on Garigliano reactor, 7/64, 18: 35147 (GEAP-4645)
Prog. rpt. on high-performance UO_2 program, 4–6/64, 18: 35127 (GEAP-3771-13)
Prog. rpt. on Pu recycling, 10–12/63, 18: 35130 (EURAEC-992)
Prog. rpt. on steady-state and dynamic behavior of BWR, 1–4/64, 18: 33733 (EURAEC-1127)
Prog. rpt. on steam separation technology, 4–6/64, 18: 33693 (ACNP-64026)
Prog. rpt. on transition boiling heat transfer, 4–6/64, 18: 33734 (GEAP-4646)
Prog. rpt. on UN, 4–6/63, 18: 34035 (BMI-X-10053)
Prog. rpt. on vapor volume fraction and slip velocity, 4–6/64, 18: 33729 (ACNP-64027)
Prog. rpt. on welding of thick steels, 10–12/63, 18: 34089 (EURAEC-915)
Uranium dioxide thermal conductivity from irradiations with central melting, 18: 34215 (GEAP-4624)

UNITED STATES NAVAL ACADEMY, ANNAPOLIS, MD.
Prog. rpt. on Pu recycle for use in H_2O-moderated reactors, 4–6/64, 18: 35128 (GEAP-4642)

UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES.
Nuclear structure calculations for deformed nuclei, 18: 34781 (UCRL-11376)

V

VIENNA. TECHNISCHE HOCHSCHULE.
Preparation of rare earth–Mn–Hg alloys, 18: 34028 (AD-430037)
Rare earth–Mn alloys, 18: 34027 (AD-428772)
Yttrium–Mn and Gd–Mn alloys, 18: 34026 (AD-428771)

W

WASHINGTON STATE UNIV., PULLMAN.
Radiation effects on Weston Cd cell, 18: 34217 (NP-14183)

WASHINGTON. UNIV., SEATTLE. COLL. OF ENGINEERING.
Statistical uncertainties in pulsed neutron and excursion experiments, 18: 35080 (TID-7679(p.347-55))

WEIZMANN INST. OF SCIENCE, REHOVOTH, ISRAEL.
Mechanisms of electron transfer reactions in solution, 18: 33521 (BNL-8081)

WESTINGHOUSE ELECTRIC CORP., LIMA, OHIO.
Prog. rpt. on converter for nuclear thermionic energy source, final, 5/3–12/3/63, 18: 34497 (NP-12888(Vol.5))
Prog. rpt. on materials for space power systems, 12/63–2/64, 18: 34046

(NASA-CR-54041)

WESTINGHOUSE ELECTRIC CORP. ASTRONUCLEAR LAB., PITTSBURGH.

Prog. rpt. on dispersion-strengthened Ta alloy, 12/20/63–3/19/64, 18: 34059 (WANL-PR(Q)-003)

Prog. rpt. on weldability and elevated temperature stability of refractory metal alloys, 12/21/63–3/21/64, 18: 34058 (WANL-PR(P)-003)

WESTINGHOUSE ELECTRIC CORP. ATOMIC POWER DIV., PITTSBURGH.

Prog. rpt. on Yankee core evaluation, 4–6/64, 18: 35165 (WCAP-6063)

Reactor noise measurements on Saxton reactor, 18: 35156 (TID-7679 (p.427-47))

WESTINGHOUSE ELECTRIC CORP. BETTIS ATOMIC POWER LAB., PITTSBURGH.

EMPIRE-1 and EMPIRE-2—codes to solve slab geometries, 18: 34732 (WAPD-TM-436)

WESTINGHOUSE ELECTRIC CORP. RESEARCH LABS., PITTSBURGH.

Recombination of molecular positive ions with electrons, 18: 34259 (AD-434907)

WISCONSIN. UNIV., MADISON.

Analysis of K^{+}_{e4} decays, 18: 34519 (UCRL-11549)

PERSONAL AUTHOR INDEX

Each entry after an author's name is a shortened version of the title of the report or article, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt.," permitting a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

A

AASA, E., Decay of Ag-106m to Pd-106, 18: 34817

ABASHIAN, A., Search for CP nonconservation in K_2^0 decays, 18: 34590

ABASOV, I. T., Changes in serum proteins, protein fractions, nonprotein, and amino nitrogen in combined radiation and burn injury, 18: 33381

ABATI, R. Anca, Reduction of UF_4 in closed bombs. I., 18: 33542

ABBE, J.-C., Ionization of gas under the effect of ions of 200 to 1200 kev, 18: 34433

ABDEL-LATIF, R. A., Polarization phenomena in direct nuclear reactions, 18: 34853

ABDULLAEV, D., Determination of composition of mixtures by β rays, 18: 33469 (AEC-tr-6399(p.72-82))

ABECASIS, Sara M., Isolation of carrier-free Pb-202m and Pb-203, 18: 33664

ABECASIS, Sara M., Isolation of carrier-free Y-90m and Mo-93m, 18: 33665

ABELEVA, E. A., Breaks in x chromosome under influence of radiation, 18: 33378

ABELEVA, E. A., Changes in radiation-induced mutations in spermatids, 18: 33371

ABOLINS, Maris A., ρ Exchange mechanism in reaction $\pi^+ + p \rightarrow N_{33}^{*++} + \pi^0$, 18: 34626

ABOU-LEILA, Hussein, Half lives of Pa-234 energy levels, 18: 34803

ABRAHAMS, Simon P., Biological effects of radiation, 18: 33401

ABRAMOVA, T. M., Investigation of oxidative destruction of polyamides. II., 18: 33669

ABRAMS, R. J., Search for CP nonconservation in K_2^0 decays, 18: 34590

ABRASHKIN, S., Production of I-131 from irradiated UO_2, 18: 33620 (NP-14187)

ABUZEID, M. A., Reaction $Al^{27}(d,\alpha)Mg^{25}$ at 1.5 to 2.6 Mev, 18: 34823

ACKERMAN, M., Scattering of K by HCl and HI in crossed molecular beams, 18: 33560

ADAMS, F., Applications of radioisotopes in analytical chemistry, 18: 33483

ADAMS, John P., Field-strength relationships for Si surface-barrier detectors, 18: 33954

ADAMS, Lawrence Richards, Cytophotometric technique and application to study of erythropoiesis, 18: 33234 (UCRL-11459)

ADEMOLLO, M., Strangeness-violating vector currents, 18: 34596

ADITYA, P. K., Coulomb scattering in nuclear emulsions, 18: 34627

ADITYA, P. K., Nuclear radii for interaction in emulsions, 18: 34964

ADLER, Stephen L., High-energy neutrino reactions, 18: 34561

ADLOFF, J.-P., Ionization of gas under the effect of ions of 200 to 1200 kev, 18: 34433

AFANAS'EV, V. N., Count-time teleradiometer, 18: 33885 (AEC-tr-6399 (p.173-6))

AFANAS'EV, V. N., Follow-up radiometric level meter, 18: 33849 (AEC-tr-6399(p.153-62))

AFANAS'EV, V. P., Technique for study of shielding properties, 18: 34374

AHMADIEH, Aziz, Lithium alloying and dislocation mechanisms in Mg, 18: 34134 (UCRL-11417)

AHRLAND, Sten, Inorganic ion exchangers. I., 18: 33535

AISU, H., Calculation of resonance integrals, 18: 34744

AIZENBERG, V. P., Presacral novocain block of radiation injuries, 18: 33339

AKALAEV, G. G., Low-energy γ transitions in Pu-238 and Pu-240, 18: 34798

AKATSU, Eiko, Solvent extraction in TBP–HNO_3 or -HCl systems, 18: 33685

AKHMADIEVA, A. Kh., Intensity and relationship between nucleic acid, protein and lipid synthesis in spleen of irradiated rats, 18: 33382

AKOEV, I. G., Recovery rate of organism after irradiation at various doses, 18: 33377

ALBEE, A. L., Redistribution of Sr and Rb isotopes during metamorphism, 18: 33793

ALBERTSSON, Joergen, Inorganic ion exchangers. I., 18: 33535

ALBRECHT, Robert W., Statistical uncertainties in pulsed neutron and excursion experiments, 18: 35080 (TID-7679(p.347-55))

ALDER, Berni J., Few-particle experiments in statistical mechanics, 18: 34663

ALEXANDER, K. F., Comparison of (n,γ) and (d,p) reaction in Co, 18: 34827

ALEXEFF, Igor, Observation of burnout in steady-state plasma, 18: 35014

ALIA, P., Liquid volume fraction in two-phase adiabatic flow, 18: 33732 (EURAEC-1086)

ALIEV, Yu. M., Particle flux and temperature in plasma in strong magnetic field, 18: 35027

ALLEGRETTI, N., Autografts and homografts in sublethally irradiated rats, 18: 33386

ALLEN, Gordon P., Fused fluoride coatings as solid lubricants, 18: 33695 (NASA-TN-D-2348)

ALLEN, Joe F., Energies of electrons and positrons emitted at time of certain nuclear reactions, 18: 34783 (ORNL-tr-235)

ALLEN, Robert C., Compact, lightweight themoelectric generators, 18: 34503

ALLERT, U., Radioprotection efficiency of histamine in mice, 18: 33414

ALLES, W., 45-Fold ϕ^+ baryon multiplet? 18: 34554

ALLIO, R. J., Gamma heating in reactor experiments, 18: 34236

ALMQVIST, E., Levels of Ne-20, 18: 34842

ALMQVIST, E., New α-emitting levels in Ne-20, 18: 34958

Alonso, Luis Garcia de Viedma
see Garcia de Viedma Alonso, Luis

ALPERT, D., Effects of electron-surface interaction in ionization gages, 18: 33759 (AD-427830)

ALTMANN, H., Trace element content of leukocytes by neutron activation analysis, 18: 33517

ALTMANN, S. L., Fermi surface of Zr, 18: 34185

ALVAEGER, T., Independence of the velocity of light of the motion of the light source, 18: 34294

AMAMOTO, Kichiro, Adolescents exposed *in utero* to atomic bomb. I., 18: 33391

AMATO, I., Fission gas release from UO_2, 18: 34214 (EURAEC-1126)

AMATO, I., Solarization and grain growth of sintered UO_2, 18: 34170

AMBEGAOKAR, V., Inelastic scattering of neutrons by anharmonic crystals,

18: 34748
AMBEGAOKAR, V., Scattering function $S(k,\omega)$ for inelastic scattering of neutrons, 18: 34460
AMIEL, S., Nuclear education and training at Israel Research Reactor, 18: 35219 (IA-894)
AMONENKO, V. M., Evaporation during thermal dissociation of Yb and La beryllides, 18: 34154
AMONENKO, V. M., Thermal expansion of W, Mo, Ta, Nb, and Zr at high temperatures, 18: 34190
AMONENKO, V. M., Deformation and fracture of rolled Be, 18: 34140
AMSTER, Harvey J., Spatial-distribution functions, 18: 34745
ANAND, S., Rayleigh scattering of γ rays, 18: 34417
ANANTAKRISHNAN, S. V., Limitations on isotopes in reaction mechanisms. II., 18: 33985
ANBAR, M., Activities of Chemistry Division, Soreq Research Establishment, 18: 33447 (IA-893)
ANDERSON, A. C., Thermal boundary resistance between solids and He below 1°K, 18: 34697
ANDERSON, J. D., Neutron spectra from the (p,n) reaction, 18: 34859
ANDERSON, J. Edward, Magnetohydrodynamic shock waves, 18: 34360
ANDERSON, Jared A., Magnetic moment of the Λ, 18: 34580
ANDERSON, L. Wilmer, Fast-passage effects in NMR of Fe-57 in Fe, 18: 33583
ANDERSON, P. W., Radio-frequency effects in superconducting thin film bridges, 18: 34710
ANDERSON, Robert B., Treating exhaust gases with urania-containing catalysts, 18: 33610
ANDERSSON, I., Double-focusing β spectrometer (50 cm), 18: 33947
ANDERSSON, I. O., Exposure following ingestion of H_2O containing Rn-222, 18: 33820
ANGER, Hal O., Scintillation camera with multichannel collimators, 18: 33940
ANTIPOV, V. V., Biological action of cosmic radiation in flights, 18: 33354
ANTIPOV, V. V., Radiation safety in flights of Soviet cosmonauts, 18: 33815
ANTOUFIEV, Y. P., Energy levels of Si-28, 18: 34822
ANTOUFIEV, Y. P., Reaction $Al^{27}(d,\alpha)Mg^{25}$ at 1.5 to 2.6 Mev, 18: 34823
AOKI, Matto, Acoustic attenuation studies of frictional force on fast moving dislocation, 18: 34276 (NP-14129)
AONO, Osamu, Energy loss by sequence of fast charges in plasma, 18: 34996
APPEL, Klaus, Inversion of cyclic matrices, 18: 34019
APPLEBY, E. R., Report on accident which occurred during purification of Pu on ion-exchange resins, 18: 33809 (HW-tr-78)
ARAJS, Sigurds, Electrical resistivity of alpha U from 2° to 300°K, 18: 34164
ARANOVITCH, Eric, Adjustable fuel and reflector element lattice, 18: 35087
ARASE, Isao, The void and hole effect in D_2O-moderated reactor, 18: 35083
ARBEL, R., Nuclear education and training at Israel Research Reactor, 18: 35219 (IA-894)
ARDAILLOU, Nicole, Digestive absorption of Fe using radioactive indicator, 18: 33440
ARDASHNIKOV, S. N., Induction of h-mutations in extracellular phage T2 by γ irradiation, 18: 33297
ARGUE, G. R., Prog. rpt. on effects of radiation on Ni–Cd battery electrodes, final, 6–12/63, 18: 34213 (AI-64-11)
ARMSTRONG, D. A., Radiolysis of gaseous HCl, 18: 33625
ARNELL, S. E., Energy levels of Mn-51, 18: 34793
ARNELL, S. E., New energy levels in K-37, 18: 34791
ARNELL, S. E., Reaction $Fe^{56}(p,\gamma)Co^{57}$, 18: 34792
ARNELL, S. E., Reaction $Cr^{52}(p,\gamma)Mn^{53}$, 18: 34797
ARNOLD, James R., Origin of meteorites, 18: 34396
ASATIANI, T. L., Polarization of cosmic muons, 18: 34490
ASTILL, C. J., Automatic sample changer for α-, β-, and γ-active sources, 18: 33716
ASTROEM, H. U., Release of stored energy from reactor-irradiated Mo, 18: 34221
ASUNDI, R. K., Preparation of $Cs_2UO_2(NO_3)_4$, 18: 33547
ATAKA, Yasusi, Maximum value for π-N coupling constant, 18: 34548
ATALLAH, Amin Edwards, Effect of stress on permeation through alumina membranes, 18: 34056 (UCRL-11355)
ATAYAN, R. R., Removal of newly gathered potato tubers from dormant stage, 18: 33376
ATLAS, Reynold, Atmospheric attenuation of thermal radiation, 18: 34256
ATTA, G. J., Gas-phase reduction of UCl_4 to UCl, with CO, 18: 33530 (ORNL-TM-829)
AU, W. S., I = 0 pion-pion amplitude and σ di-pion, 18: 34579
AUBLE, R. L., Decay of Te-121 and Te-121m, 18: 34882
AUERBACH, E. H., Calculations of inelastic scattering of neutrons by heavy nuclei, 18: 34910
AUERBACH, E. H., Neutron-nucleus optical model parameter effects on s-wave transmission coefficients, 18: 34866
AULT, Robert G., Generation of power using emissive materials, 18: 34505
AUSLOOS, P., Gamma radiolysis of propane, 18: 33642
AUSLOOS, P., Proton-transfer reactions between H_3^+ and saturated hydrocarbons, 18: 33639
AUSTIN, Arthur L., Thermally induced vibrations of concentric thin spherical shells, 18: 33755
AVAEV (AVAYEV), V. N., Counters and dosimeters for studying shielding and protective properties of materials, 18: 33886 (JPRS-25467(p.9-24))
AVAEV (AVAYEV), V. N., Protective properties of concrete, 18: 35092 (JPRS-25467(p.1-8))
AVAKYAN, Ts. M., Removal of newly gathered potato tubers from dormant stage, 18: 33376
AZHAZHA, V. M., Deformation and fracture of rolled Be, 18: 34140

B

BACHYNSKI, M. P., Free-space microwave techniques for plasma measurements, 18: 35020
BACHYNSKI, M. P., Plasma trapping within the magnetosphere, 18: 34984
BADAWY, O. E., Energy levels of Si-28, 18: 34822
BAGDASAROV, Yu. E., Transient regimes of natural circulation in multi-circuit reactor system, 18: 35081
BAGLIN, J. E. E., Photodisintegration of Ca, 18: 34629
BAILEY, Carl L., Prog. rpt. on distribution of electrons from gases ionized by proton impact, 4–7/64, 18: 34404 (COO-1277-5)
BAILEY, J. M., Fine-structure constant from muonium hfs interval, 18: 34921
BAILEY, M. G., Radiation-decomposition of three low-melting organic coolants, 18: 33617 (AECL-1915)
BAILEY, Richard F., Determination of O in GaAs by neutron activation, 18: 33541
BAIR, J. K., Nuclear resonance and Coulomb excitation in $Na^{23}(p,p')$ reaction, 18: 34836
BAK, Thor A., Phonons and phonon interactions, 18: 34451
BAKER, A. R., Prog. rpt. on converter for nuclear thermionic energy source, final, 5/3–12/3/63, 18: 34497 (NP-12888(Vol.5))
BAKER, George A., Jr., Ground state of a many-fermion system. II., 18: 34559
BAKER, M. McD., Influence of O on U–H_2O reaction. III., 18: 34072 (AWRE-O-40/64)
BAKHRU, H., Radioactive decay of Lu-178, 18: 34843
BAKKEN, J. A., Calculations on shock tubes with current crowbarring, 18: 34330
BALASHKO, Yu. G., Elastic scattering of protons by H-3, 18: 34944
BALASUBRAHMANYAN, V. K., Primary cosmic radiation near solar minimum, 18: 34481
BALBER, David, Device for measuring gas pressure, 18: 33874
BALESCU, R., Kinetic equation for an inhomogeneous plasma, 18: 34995
BALLINI, Rene, Use of multiparameter recorder, 18: 33859
BALNER, H., Persistence of tolerance toward donor-type antigens in rats, 18: 33387
BALTON, I. A., Observations of 1962 Johnston Island nuclear tests, 18: 34676
BALZARI, A. Petruccioli, Elastic properties at high temperature of stainless steel, 18: 34175
BAME, S. J., Time-of-flight measurements made with neutrons from nuclear explosions in space, 18: 34751 (CONF-481-71)
BANAIGS, J., Coulomb scattering in focusing media—FORTRAN programs, 18: 34368 (CERN-64-29)
BANASHEK, V. E., Radioactive instruments for automatization in chemical industry, 18: 33990 (AEC-tr-6399(p.258-76))
BANBURY, P. C., Displacement energy in GaAs, 18: 34352
BAND, I. M., Many-nucleon system in shell-model potential, 18: 34826
BANERJEE, D., Nuclear binding energies, 18: 34812
BARACH, J. P., Flux transport by shock plasma, 18: 35007
BARADZEY, L. T., Variations of cosmic rays at 9 to 12 kilometers, 18: 34464 (NASA-TT-F-126(p.180-6))
BARANIK, A. T., Reaction $Al^{27}(d,\alpha)Mg^{25}$ at 1.5 to 2.6 Mev, 18: 34823
BARANOV, N. I., Radioactive contamination of seas and oceans, 18: 33779
BARASHENKOV, V. S., Interaction of cosmic particles with nuclei, 18: 34764 (JINR-P-1678)
BARAT, Michel, Energy losses by rare gas ions after collisions with rare gas atoms, 18: 34416
BARBARO-GALTIERI, Angelo, Search for $K^- p \to \Lambda\mu^+\mu^-$ or $\Lambda e^+ e^-$ at 2.7 Bev, 18: 34513 (UCRL-11428)
BARBER, A. C., Systems Nb–Zr–C and Nb–Zr–O, 18: 34211
BARCUS, J. R., Particle precipitation during auroral zone phenomena, 18: 34671 (AFOSR-425)

BARENKO, Yu. S., Changes in sensitivity of irradiated mice toward endotoxins, 18: 33370
BARHAM, David C., Surface temperature measurements on burning solids, 18: 33581
BARIT, I. Ya., Elastic scattering of protons by H-3, 18: 34944
BARKAN, S., Operation of cloud chamber at low He pressure, 18: 33942
BARKER, W. A., Low-temperature dynamic nuclear polarization, 18: 34717
BARREIRA, F. C., Saturation backscattering of β particles, 18: 35057
BARRETO, E., Performance of electrogasdynamic generators, 18: 34501
BARTLETT, E. S., Transition properties of wrought Ta and Nb, 18: 34196
BARTONICEK, B., Radiation effects on ketone extraction. II., 18: 33621 (UJV-977/64)
BARTOSEK, Vaclav, Physics of heavy water lattices, 18: 35120
BARUT, A. O., I = 0 pion-pion amplitude and σ di-pion, 18: 34579
BARZ, H. W., Inelastic nucleon scattering on deformed nuclei, 18: 34865
BASHKIROVA, I. S., Photometric determination of Zr in Mg and Al alloys, 18: 33512
BASS, J. C., Beam stability in wave amplifiers, 18: 34379
BASSEL, R. H., Applications of distorted wave approximation for direct nuclear reactions, 18: 34774 (ORNL-P-144)
BASSI, A., Chemical stripping of direct carbon replicas, 18: 33549
BASSO, Giuseppe, Purification of organic moderators-coolants, 18: 33667
BASTIDE, R. P., Production of intense negative He and H ion beams, 18: 34381
BASU, Prasanjit, Once-forbidden β transitions, 18: 34957
BATANOV, G. M., Particle losses and configuration of plasma jet moving along curved magnetic field, 18: 35023
BATIKYAN, I. G., Effect of certain hormones on hemopoiesis and survival of irradiated mice, 18: 33416
BATTERMAN, Boris W., Dynamical diffraction of x rays by perfect crystals, 18: 34354
BATYEV, E. G., Phase transition in superconductors, 18: 34719
BAUDON, Jacques, Energy losses by rare gas ions after collisions with rare gas atoms, 18: 34416
BAUER, Walter, Point defect studies in Au. II., 18: 34249
BAUMAN, R. C., Effects of steam pressure on reactor economics, 18: 35184
BAXTER, J. A., Liquid scintillation solvent systems, 18: 33938
BEACH, S. A., Determination of Pu body burdens, 18: 33267
BEALL, S. E., Reactor safety analysis, MSRE design, 18: 35152 (ORNL-TM-732)
BEAN, C. P., Prog. rpt. on superconducting properties of materials, 12/15/63–6/15/64, 18: 34683 (NP-14136)
BEARDEN, J. A., Absolute scale of x-ray wave lengths, 18: 34340
BEARDEN, J. A., Standard reference wave lengths for x-ray spectroscopy, 18: 34341
BEAUMARIAGE, M. L., Radioprotection of coat of small mice by anoxia, 18: 33408
BECK, R. L., CANDU power costs competitive with BWR, 18: 35172
BECKER, K., High-level dose effects in silver-activated metaphosphate glasses, 18: 33891 (ORNL-tr-216)
BECKNER, E. H., Rapid scan spectrograph for plasma spectroscopy, 18: 34983
BEDNYAKOV, A. A., Multiple scattering of 75- to 200-kev protons in solids, 18: 34943
BEENTJES, Lucas B., Weighed gonadal diagnostic x-ray doses, 18: 33419
BEGLEY, R. T., Prog. rpt. on dispersion-strengthened Ta alloy, 12/20/63–3/19/64, 18: 34059 (WANL-PR(Q)-003)
BELEW, W. L., Developments in d-c polarography, 18: 33452 (ORNL-P-145)
BELINA, G. L., Gamma-absorption method for control of Pb content, 18: 33468 (AEC-tr-6399(p.61-71))
BELINFANTE, John G., Scattering solutions for the Schroedinger equation, 18: 34652
BELL, B., Concerning a lunar modulation of geomagnetic activity, 18: 34677
BELL, R., Nuclear reaction $^{191}Ir(n,\gamma)^{192}Ir$ in $Na_2IrCl_6 \cdot 6H_2O$, 18: 33662
BELL, R. E., Decay of Ne-17 and delayed proton emission, 18: 34899
BELLIER, Jean, Prestressed concrete containers of G2 and G3, 18: 35196
BELYKH, L. G., Measurement of humidity of friable materials by neutron method, 18: 33466 (AEC-tr-6399(p.43-50))
BEM, P., Polarization measurements with protons scattered on C, 18: 34809
BENEDICT, Andrzej, Volumetric determination of Gd, 18: 33481
BENEVOLENSKII, V. N., Proteolysis of blood of irradiated rats, 18: 33362
BENNETT, A. W., Heat transfer to high-pressure steam and water in annulus. VI., 18: 33730 (AERE-R-4352)
BENO, Milan, Metabolism of Ce-144, 18: 33252
BERARD, Costen W., Effect of D_2O on wound healing, collagen, and metabolism, 18: 33250
BEREZINA, N. M., Application of radiations in hydroponics, 18: 33997
BERGER, H., Characteristics of thermal neutron beam for neutron radiography, 18: 33995
BERGER, M., Low-frequency motions in isotactic and atactic polypropylene by neutron inelastic scattering, 18: 34265 (BNL-7320)
BERGSNOV-HANSEN, B., Prog. rpt. on sorption of gases on metal surfaces in vacuum, 2/15–5/15/64, 18: 34282 (TID-20837)
BERICK, A., Large aperture time-of-flight counter system, 18: 33972
BERICK, A., Survey of 60° beam at Princeton-Pennsylvania accelerator, 18: 34380
BERKNER, Klaus H., Collisional excitation and Lorentz ionization of 10-Mev H atoms, 18: 34408 (UCRL-11249)
BERKO, S., Single-valued time-to-pulse-height system, 18: 33931
BERKOV, A. V., Regge poles and amplitude production of vector mesons, 18: 34622
BERLANDE, J. A., Microwave interactions in cryogenic afterglow plasmas, 18: 35015
BERLMAN, I. B., Fluorescence decay-time measuring apparatus, 18: 33637
BERMAN, S. M., Angular correlations in production processes, 18: 34569
BERNARD, Yvette, Radioprotective activity of nitrogenous heterocyclic compounds, 18: 33406
BERNATSKAYA, M. V., Simultaneous determination of Zr and S in organic compounds, 18: 33514
BERNDT, A. F., Crystal study of alpha Pu–Np alloy, 18: 34171
BERNHEIM, M., Excitation of levels of N-14 by electron scattering, 18: 34825
BERNSTEIN, Bruce S., Radiation crosslinking of polyisobutylene, 18: 33652
BERTET, Michel, Iodine-131 formed in neutron irradiation of Te compounds, 18: 33661
BERTHELOT, A., Non-strange resonances, 18: 34636
BESSIS, N., Hyperfine splitting of ^3D levels of He-3, 18: 34903
BESSOUAT, R., Measurement of viscosities at temperatures to 500°C and pressures to 200 kg/cm², 18: 33858
BETIN, Yu. P., Measurement of humidity of friable materials by neutron method, 18: 33466 (AEC-tr-6399(p.43-50))
BETTINGER, Richard T., Relationship for plasma sheaths about Langmuir probes, 18: 35043
BEVILACQUA, S., Data recording system for physics experiments, 18: 33837 (RT/EL(64)-8)
BEVOLO, Albert J., Low-temperature dynamic nuclear polarization, 18: 34717
BEWIG, K. W., Ionization method of measuring contact potential differences, 18: 33863
BEWLEY, J. C., Prog. rpt. on Nb (Cb-752) alloy, 7–11/63, 18: 34025 (AD-428036)
BHAGAT, S. M., Vorticity in liquid He-II, 18: 34691
BHATTACHARYA, D. M., Phase shift calculation of electron scattering, 18: 34528
BHAUMIK, M. L., Fluorescence in rare-earth chelates, 18: 33556
BHAUMIK, M. L., Ligand field spectra of some new laser chelates, 18: 33565
BIAGINI, C., Representation of the pancreas by scintigraphy, 18: 33442
BIALKOWSKI, G., K^+-p scattering, 18: 34543
BIALYNICKI-BIRULA, I., Electron propagator in two-component formulation of quantum electrodynamics, 18: 34646
BIENLEIN, J. K., Gamma spectroscopy in decay $Mn^{56} \rightarrow Fe^{56}$, 18: 34840
BILINSKI, J. R., Radiation effects handbook, 18: 34245
BILLARD, F., Trapping of I by active charcoals, 18: 33808 (AEC-tr-6459)
BINGHAM, Carleton D., Determination of C in Na, 18: 33477
BINNER, C. R., Heat exchanger, 18: 33754
BIONDI, M. A., Recombination of molecular positive ions with electrons, 18: 34259 (AD-434907)
BIRD, Joseph F., Massive condensations in interstellar matter, 18: 34394
BIRGE, Robert W., Analysis of $K^+_{\mu 4}$ decays, 18: 34519 (UCRL-11549)
BIRKBECK, Claire M., Low-temperature dynamic nuclear polarization, 18: 34717
BIRKHOFF, R. D., Positron flux in infinite Cu medium containing Cu-64, 18: 34904
BIRKS, J. B., Scintillation process in alkali halide crystals, 18: 33636
BIRYUKOV, E. I., Mean energy of Pr-142 β spectra, 18: 34954
BISHOP, A. S., Recent developments in controlled fusion, 18: 35017
BISHOP, G. R., Excitation of levels of N-14 by electron scattering, 18: 34825
BISWAS, S. N., Low-energy $\bar{K}N$ interaction and Y_1^* Regge pole, 18: 34571
BIZOLLON, Ch. A., Application of γ spectrometry to analysis of radioisotope traces in water, 18: 33485
BJOERNHOLM, S., Preparing α- and β-spectroscopy sources, 18: 33654
BLACK, P. J., Diffraction in nuclear resonant scattering, 18: 34929
BLAIR, I. M., Resonance in the dipion mass region 280 to 350 Mev, 18: 34552

BLALOCK, T. V., Low-noise charge-sensitive preamplifier, 18: 33927
BLANCO, R. E., Processing graphite reactor fuels, 18: 33687
BLANKENSHIP, J. L., Design of low-noise vacuum-tube pulse amplifiers, 18: 33928
BLASIUS, E., Chelate-forming exchanger resins. V., 18: 33508
BLELOCH, J. W., Influence of O on U–H_2O reaction. III., 18: 34072 (AWRE-O-40/64)
BLINOWSKA, K. J., Decay of 23.5-min U-239, 18: 34850
BLOCK, E. Z., GANDS—program to derive Westcott parameters, 18: 34015 (HW-81117(Rev.1))
BLOEMBERGEN, N., Nuclear quadrupole coupling of Cl-35 in Na chlorate, 18: 34301
BLOKH, Ye. L., Meteorological cosmic-ray effects below ground, 18: 34468 (NASA-TT-F-126(p.220-3))
BLOKH, Ye. L., Standard cubical telescope, 18: 33887 (NASA-TT-F-126 (p.102-37))
BLUM, Pierre-Lazare, Uranium oxycarbide–dioxide eutectic, 18: 34144
BOARDMAN, F. D., Noise measurements in Dounreay Fast Reactor, 18: 35158 (TID-7679(p.469-500))
BOATO, Giovanni, Separation factor in isotopic phase equilibria, 18: 34013
BOBOVINKOVA, Ts. I., Strontium-90 content in fresh water reservoirs, 18: 33769 (NP-14091)
BOCHENEK, Krystyn, Problems in magnetogasdynamics. I., 18: 35028
BOCHENEK, Krystyn, Shock waves and their numerical determination, 18: 35032
BOCKASTEN, Kjell, Polarization formula for ^2F series of CsI, 18: 33580
BOCQUET, Colonel, Pollution of environment by radioactivity, 18: 33300
BODDY, K., Calculation of Te and I fission-product activities, 18: 35228
BODENSTEDT, E., g-Factor of 248 kev state of Se-77, 18: 34895
BODYASHINA, V. I., Effects of radiation on ovaries, pregnancy, and the fetus, 18: 33395
BOEHLER, T., Steel irradiation program, 18: 34219 (RCN-26)
BOEMMEL, H. E., Superconductivity in the artificial metals, 18: 34707
BOFFI, V. C., Thermal parameters and neutron spectra in organic moderators, 18: 34734
BOGDANOV, N. I., Sources of x rays with Sr-90–Y-90 as base, 18: 33989 (AEC-tr-6399(p.243-57))
BOHUN, A., Electron emission of LiF crystals, 18: 33632
BOLANOWSKA, Wanda, Effect of EDTA on absorption and excretion of Pb, 18: 33249
BOLDHAUPT, LaVerne, X-irradiation effects on nuclei of mouse liver cells, 18: 33350
BOLEY, Forrest I., Atmospheric Cherenkov radiation from cosmic-ray air showers, 18: 34488
BOLOTIN, N. H., Decay of Te-121 and Te-121m, 18: 34882
BOLOTOV, V. N., Shower efficiency of spark chamber, 18: 33966
BOLSTERLI, M., Intermediate-vector-boson theory of weak interactions, 18: 34531
BOMKE, H. A., Observations of 1962 Johnston Island nuclear tests, 18: 34676
BONACALZA, E. C. O., K Auger group intensities in Cl-37, 18: 34789
BONACALZA, E. C. O., K Auger effect in Br-79, 18: 34788
BONACALZA, E. C. O., Search for vibrational levels in Br-79, 18: 34790
BOND, W. D., Production of tritium by contained nuclear explosions in salt, 18: 33529 (ORNL-3334(Pt.II))
BONNAURE, Pierre, Adjustable fuel and reflector element lattice, 18: 35087
BONNET, Georges, Improvements in devices for measuring small magnetic fields, 18: 33870
BOOTH, E. C., Fluorescence from light and medium-weight nuclei, 18: 34852
BORCHERS, H., Deformation of Zr sheets during oxidation, 18: 34081
BORISHANSKII, V. M., Heat transfer between separated bunches of rods with longitudinal flow of metallic Na, 18: 33744
BORODINA, E. N., Spectra of blood serum absorption with ionizing radiation and low temperature, 18: 33335
BOROWITZ, J. L., Pre-enrichment of tritium for low-level counting, 18: 34011
BORUKHOV, M. Yu., Automatization of cycle of crushing and classification of ores using isotopes, 18: 33988 (AEC-tr-6399(p.227-42))
BOSE, S. K., Low-energy $\bar{K}N$ interaction and Y_0^* Regge pole, 18: 34571
BOSTICK, F. X., Jr., Ionospheric transmission of transversely propagated plane waves, 18: 34679
BOTSFORD, Thomas W., Experiences with radioactive colloidal Au in treatment of pleural effusion, 18: 33439
BOULANGER, J. R., SNAP-10A structural analysis, 18: 35202 (NAA-SR-9655)
BOULGER, Francis W., Machining of refractory metals, 18: 34106
BOULIGAND, Georges-Marie, Differential systems of flux and concentrations of mixture in separation by plant stage, 18: 34004 (CEA-R-2337)
BOURDEAU, P. F., Carbon dioxide exchange by *Pinus rigida* trees exposed to irradiation, 18: 33315
BOURGADE, Pierre, Thermal barrier for nuclear reactor vessel, 18: 35104
BOUTIN, H., Low-frequency motions in isotactic and atactic polypropylene by neutron inelastic scattering, 18: 34265 (BNL-7320)
BOWERS, D. J., Refractory ceramics of interest in aerospace structural applications, 18: 34129 (RTD-TDR-63-4102(Suppl.1))
BOWERS, R., New type of flux meter, 18: 33865
BOWLES, D. L., Prog. rpt. on converter for nuclear thermionic energy source, final, 5/3–12/3/63, 18: 34497 (NP-12888(Vol.5))
BOWMAN, G. P., Investigation of the $PbMoO_4$–$Bi_2(MoO_4)_3$ phase diagram, 18: 34195
BOX, W. D., Vacuum distillation of Mg metal, 18: 34051 (ORNL-TM-749)
BOYCE, Richard P., DNA of uv-irradiated *E. coli*, 18: 33298
BOYD, L. R., In-core instrumentation, 18: 35089 (TID-8540(p.177-211))
BOYER, Keith, Large volume operational room inerting, 18: 33804 (LADC-6432)
BOYLING, J. B., Majorization of Feynman diagrams, 18: 34521
BOZE, J. M., III, Power system for manned earth orbital space station, 18: 33719
BOZEK, E., Hfs interaction of Gd-155 nucleus, 18: 34898
BOZOKI, G., Inelastic two-prong π^--p interactions, 18: 34520
BOZZINI, A., Mutagenesis in the genetic improvement of asparagus, 18: 33323
BRADLEY, C. J., Fermi surface of Zr, 18: 34185
BRADY, A. P., Prog. rpt. on sorption of gases on metal surfaces in vacuum, 2/15–5/15/64, 18: 34282 (TID-20837)
BRAGIN, A. A., Increasing efficiency of transmission of radioactive-emission parameters, 18: 33853 (AEC-tr-6399(p.207-20))
BRAHMER, Anna, Electric conductivity and dielectric constant of plasma, 18: 35036
BRAHMER, Anna, Problems in magnetogasdynamics. I., 18: 35028
BRANEMARK, P. I., Regeneration of bone marrow, 18: 33216
BRANYAN, C. E., Loading to criticality of Fermi reactor, 18: 35139 (APDA-NTS-1)
BRAUDO, C., Nuclear education and training at Israel Research Reactor, 18: 35219 (IA-894)
BRAUN, M. T., Coatings for earth re-entry systems, 18: 34209
BRAUNBEK, W., Neutrinos everywhere, 18: 34598
BRAY, A. Elastic properties at high temperature of stainless steel, 18: 34175
BRAYER, R. C., Prog. rpt. on burnable poison additions to UO_2, 4–6/64, 18: 35126 (CEND-3107-216)
BREAZEALE, William M., Neutronic reactor, 18: 35233
BRECHER, C., Laser phenomena in Eu chelates. IV., 18: 33561
BRECHER, George, Radiation bleeding, 18: 33291
BREDEL, V. V., Ratio of cross sections for formation of isomer pair Sc-44, 44m, 18: 34948
BREHM, J. J., T = 0 pion-pion scattering, 18: 34573
BREINE, U., Regeneration of bone marrow, 18: 33216
BREIZY, C. E., Prog. rpt. on fast ceramic reactor program, 1–3/64, 18: 35146 (GEAP-4601)
BRENT, Robert L., Lethal effects of irradiation to mammalian fetus, 18: 33423
BRILL, A. Bertrand, Adolescents exposed *in utero* to atomic bomb. I., 18: 33391
BRINKMAN, B., Radiomimetic toxicity of ozonized air, 18: 33334
BRINKMANN, D., NMR shift of Xe-129 in solid Xe, 18: 34919
BRITTIN, Wesley E., Dynamics of ionized media, 18: 34971 (ARL-64-85)
BRIXNER, Berlyn, Automatic lens design by statistical analysis, 18: 35245 (LADC-6205)
BROADWELL, James E., Shock structure in simple discrete velocity gas, 18: 34325
BROCKHOUSE, B. N., Phonons and neutron scattering, 18: 34455
BRODERICK, Richard J., Thermoluminescent dosimeter, 18: 33981
BRODIN, B. V., Hard bitumen in U-bearing veins, 18: 33795
BROOKS, N. B., Production of intense negative He and H ion beams, 18: 34381
BROOKS, Philip Russell, Molecular scattering at thermal energies, 18: 34407 (UCRL-11071)
BROPHY, J. H., Activated sintering of W, 18: 34098
BROSSMANN, G., Two- and many-component systems with Pu. II., 18: 34125 (KFK-220)
BROUILLARD, F., Charge exchange cross sections of Hg and Xe ions in air, 18: 34409
BROWN, Alexander Baillie, Production of Be having increased ductility at high temperatures, 18: 34070
BROWN, F., Krypton-81 half-life determination, 18: 34881
BROWN, H. M., Fractionation of Ge isotopes in chemical reactions, 18: 33626
BROWN, James Robert, Improvements in radioactivity contamination monitors, 18: 33973

BROWN, Robert Nash, Device for measuring gas pressure, 18: 33874
BROWN, W. Byers, Differential equations of Brillouin-Wigner perturbation theory, 18: 34024
BROWN, W. K., Electron drift velocities in noble and "moderator" gases, 18: 34322
BROWNE, J. C., Electronic properties of Li hydride, 18: 34444
BROWNELL, G. L., Cesium-137 fallout in muscle samples, 18: 33427
BRUNETTI, A., Data recording system for physics experiments, 18: 33837 (RT/EL(64)-8)
BRUSSAARD, P. J., Angular distribution of de-excitation γ rays in Coulomb excitation with large energy loss, 18: 34965
BRYDEN, A. D., Equivalence of manifestly covariant theories for spin$^{3/2}$, 18: 34547
BRYKALSKI, Dariusz, Effect of EDTA on absorption and excretion of Pb, 18: 33249
BUCHHOLD, T. A., Prog. rpt. on superconducting properties of materials, 12/15/63–6/15/64, 18: 34683 (NP-14136)
BUCKLEY, Cornelius J., Thermoluminescent dosimeter, 18: 33981
BUCKMAN, R. W., Jr., Prog. rpt. on dispersion-strengthened Ta alloy, 12/20/63–3/19/64, 18: 34059 (WANL-PR(Q)-003)
BUDZANOWSKI, A., Elastic scattering of 24.7-Mev α particles, 18: 34902
BUECHNER, W. W., Shell-model states in Ca-49, 18: 34905
BUESCH, Siegfried, Apparatus for irradiation or vacuum-coating of specimens, 18: 33763
BUHLER, R. D., Heat transfer study for arc-jet engines, 18: 33752
BUHN, P., Solubility of N in Ta, 18: 33595
BURBIDGE, G. R., Cosmic rays as an extragalactic phenomenon, 18: 34486
BURCEV, P., Mechanics of photon rockets in the general theory of relativity, 18: 34649
BURCHAM, W. E., Depolarization of deuterons in sector-focused cyclotron, 18: 34378
BURDI, G. F., SNAP technology handbook, 18: 35198 (NAA-SR-8617 (Vol.I))
BURN, K. N., Calibration of neutron moisture meter in leda clay, 18: 33897
BURNS, Gerald, Atomic shielding parameters, 18: 34428
BUROVA, N. N., High-temperature oxidation of Nb alloyed with Ti and Mo, 18: 34079
BURRIS, Leslie, Jr., Pyroprocessing of reactor fuels, 18: 33683 (TID-8540(p.411-76))
BURRO, Gerard N., Adolescents exposed *in utero* to atomic bomb. I., 18: 33391
BURT, Raymond C., Nuclear fuel scheduling for Malibu nuclear plant, 18: 35187
BURT, Robert C., Nuclear fuel scheduling for Malibu nuclear plant, 18: 35187
BURTON, R. A., Prog. rpt. on liquid-metal lubricated journal bearings, 4–6/64, 18: 33697 (SWRI-1228-26)
BUSCH, G., Specific heat measurements of EuSe and EuTe, 18: 34695
BUSE, John, Scintillation scanning of kidneys, 18: 33433
BUSE, Marie G., Scintillation scanning of kidneys, 18: 33433
BUSS, D. J., Single-quantum annihilation of positrons, 18: 34577
BUTCHER, Benjamin R., Metallic fuels, 18: 34130 (TID-8540(p.331-410))
BUTLER, J. D., EMPIRE-1 and EMPIRE-2—codes to solve slab geometries, 18: 34732 (WAPD-TM-436)
BUTTLE, P. J. A., Neutron tunneling process in Coulomb field, 18: 34894
BUTTON, D. D., Grain growth and sintering of $Y_{0.33}Zr_{0.67}O_{1.83}$, 18: 34212
BUTTON-SHAFER, Janice, Ξ^0(1530-Mev) spin and parity, 18: 34517 (UCRL-11436)
BYERS, David C., Heavy-molecule propellants in electron-bombardment thrustor, 18: 33696 (NASA-TN-D-2401)
BYSTRAND, Fred W., Cohesive energy of solid Ne, 18: 34413

C

CABIBBO, Nicola, Unitary symmetry and nonleptonic decays, 18: 34578
CABRINI, A., Influence of rate cooling from γ phase on U alloys, 18: 34127 (RT/MET(64)-2)
CADILHAC, Michel, Neutron thermalization in absorbing infinite and homogeneous media, 18: 34727 (CEA-R-2368)
CALAIS, Jean-Louis, Inversion of cyclic matrices, 18: 34019
CALDWELL, Douglas R., Oscillating boundary layer in magnetohydrodynamics. II., 18: 34328
CALLAGHAN, Edmund E., Magnetic field from finite thin cone, 18: 34273 (NASA-TN-D-2400)
CALORI, Arturo, Errors in determination of leak rate in reactor containers, 18: 33757
CALVIN, Melvin, Quantum conversion in chloroplasts, 18: 33218
CAMBOU, Francis, Tritium-loaded targets used in accelerators producing neutrons, 18: 34375
CAMERINI, U., Analysis of $K^0_{\pi 4}$ decays, 18: 34519 (UCRL-11549)
CAMIZ, P., 2^+ States of O-16 with T = 0, 18: 34814
CAMONA, G., Chemical stripping of direct carbon replicas, 18: 33549
CAMPBELL, R. B., High-temperature nuclear particle detector, 18: 33918
CAMPION, R. J., Kinetics of some related electron-transfer reactions, 18: 33550
CANEPA, P. C., High-temperature nuclear particle detector, 18: 33918
CANFIELD, J. M., Total energies from numerical self-consistent field calculations, 18: 34437
CANN, G. L., Heat transfer study for arc-jet engines, 18: 33752
CANNINGTON, P. H., Reaction $Si^{28}(\gamma,p)Al^{27}$, 18: 34901
CANNON, J. R., Determination of diffusivity of isotropic medium, 18: 34018
CANTARELL, I., Time-dependent field emission of photomultiplier tubes, 18: 33910
CANTIN, M., Secondary emission statistics, 18: 33911
CAPE, J. A., Superconductivity in some alloys of Ti with Mn and Co, 18: 34700
CAPITINI, Robert, Luminous sources for U isotope measurements by emission spectrometry, 18: 33459 (CEA-R-2428)
CARACH, Jozef, Contribution to Sr-90 determination in fallout and soil, 18: 33776
CARDINI, L., Paleotemperature analysis of fossil shells of marine mollusks, 18: 33784
CARLTON, Terry S., Gaseous ion recombination rates. III., 18: 33555
CARLUCCI, A., Automatic counting scaler, 18: 33884 (RT/EL(64)-7)
CARMELI, M., Geodesic postulate, 18: 34335
CARMONY, D. Duane, ρ Exchange mechanism in reaction $\pi^+ + p \rightarrow N^{++}_{33} + \pi^0$, 18: 34626
CARMONY, D. Duane, T = 2 pion-pion interaction, 18: 34630
CARPENTER, D. W., Search for CP nonconservation in K^0_2 decays, 18: 34590
CARPER, H. J., Prog. rpt. on liquid-metal lubricated journal bearings, 4–6/64, 18: 33697 (SWRI-1228-26)
CARR, Barney J., Pulsed neutron generator, 18: 34749
CARR, D. L., Satellite instrumentation for measurement of auroral phenomenon, 18: 33935
CARROLL, C. O., Single-quantum annihilation of positrons, 18: 34577
CARROLL, P. K., Vibrational structure in some weaker systems of N_2, 18: 33568
CASANOVA, Gualtiero, Separation factor in isotopic phase equilibria, 18: 34013
CASARETT, George W., Microangiography as a technique, 18: 33289
CASTLE, R. A., SNAP-2 structural and dynamic analysis, 18: 35199 (NAA-SR-9054)
CATHERS, G. I., Processing graphite reactor fuels, 18: 33687
CAUSSE, J. P., Photon scintillator, 18: 33908
CECCALDI, Maurice, Analysis of H_2O–D_2O mixtures, 18: 33460 (CEA-R-2440)
CEGELSKI, W. M., Fission-product release from irradiated U–ZrH SNAP fuel, 18: 34045 (NAA-SR-9673)
CHAAR, E., Determination of radioactivity of minerals by x rays, 18: 33794 (NP-14176)
CHADWICK, Donald R., Biological effects of radiation, 18: 33401
CHAGNON, P. R., Geometrical corrections in triple-correlation experiments, 18: 33952
CHAKHAVA, O. V., Effect of dysentery and staphylococcus bacteria on immunity of irradiated animals to typhoid bacteria, 18: 33369
CHALAYA, V. G., Internal photoeffect in CdS single crystals excited with x rays, 18: 34286 (AEC-tr-6399(p.186-95))
CHAMBERS, R. H., Prog. rpt. on mechanical properties of reactor materials, 1/64, 18: 34039 (GA-5340)
CHAMBERS, R. H., Prog. rpt. on reactor materials, 10/62–9/63, 18: 34122 (GA-4900)
CHAMINADE, R., High stability multiparametric modular circuitry at Saclay's cyclotron, 18: 33936
CHAN, Sunney I., Rotational magnetic moment of the H molecule, 18: 34436
CHANDLER, B. A., Thermal stress evaluation of ceramic fuel elements, 18: 34166
CHANDRA, Prakash, Photoreactivation of uv-inactivated polyuridylic acid, 18: 33392
CHANDRA, S., Geomagnetic control of diffusion in the upper atmosphere, 18: 34678
CHANG, Tien Sun, Hydromagnetic stability of inviscid vortex flow, 18: 34363
CHANG, Tien Sun, Reflection of strong blast waves, 18: 34324
CHANG, Y. S., Diagnosis and treatment of cancer with radioactive isotopes. I., 18: 33438
CHANUT, Yves, Iodine-131 formed in neutron irradiation of Te compounds, 18: 33661
CHAO, P. J., Applying protective coatings to Nb alloys, 18: 34052 (RTD-TDR-63-4063)
CHAPMAN, K. R., Production of He-3 from deuteron interactions, 18: 34544

CHAPPELL, Willard R., Dynamics of ionized media, 18: 34971 (ARL-64-85)
CHARAKHCH'YAN, A. N., Radiosonde for measuring intensity of cosmic radiation, 18: 33890 (NASA-TT-F-126(p.177-9))
CHARLES, B. N., Atmospheric attenuation of thermal radiation, 18: 34256
CHASAN, B., Fluorescence from light and medium-weight nuclei, 18: 34852
CHASE, R. L., Transistorized analog-to-digital converter, 18: 33873
CHATELET, J., Activity measurement of β emitter radioelement, 18: 33946
CHATTARJI, D., Angular distribution of de-excitation γ rays in Coulomb excitation with large energy loss, 18: 34965
CHATTERJEE, A., Alpha reaction cross sections for 14-Mev neutrons, 18: 34887
CHAUVIN, G., Electrorefining of U in molten salt bath, 18: 34093
CHEN, Francis F., Double-probe method for unstable plasmas, 18: 35021
CHEN, Joseph C. Y., Theory of subexcitation electron scattering by molecules. I., 18: 34303
CHEN, Joseph C. Y., Theory of subexcitation electron scattering by molecules. II., 18: 34304
CHEN, K. W., Electroproduction of protons at 1 and 4 Bev, 18: 34916
CHERNAVSKAYA, N. M., Radiation effects on acetylcholine and sympathin content in brain, 18: 33325
CHERNOCK, W. P., Prog. rpt. on burnable poison additions to UO_2, 4–6/64, 18: 35126 (CEND-3107-216)
CHERTKOV, I. L., Bone marrow transplantation to irradiated dogs, 18: 33337
CHERUBINI, J. H., Characterization of spheroidal UO_2 particles and fabrication variables for fuel plates, 18: 34088 (ORNL-3645)
CHESHIRE, I. M., Resonant charge transfer by fast protons in atomic H, 18: 34447
CHEVALIER, G., Trapping of I by active charcoals, 18: 33808 (AEC-tr-6459)
CHLUMECKA, V., Liberation of desoxy-ribo-poly-nucleotides from irradiated tissues, 18: 33308
CHOI, Sang Up, Effect of O on radiolysis of liquid methanol. III., 18: 33618 (CONF-322-14)
CHOL, Gerard, Superconducting behavior of alloys of Pb and Sn, 18: 34693
CHONE, B., Fluorescence microscopy observations on bone marrow under radiation therapy, 18: 33399
CHOUDHURY, S. Rai, Dynamics of Ω^-, 18: 34568
CHRIEN, R. E., Time-shared time-of-flight analysis by computer, 18: 33958
CHRISTENSON, J. H., Spatial accuracy in system of spark chambers, 18: 33924
CHRISTIAN, J. E., Lean body mass from K-40 measurements, 18: 33487
CHU, C. K., Kinetic-theoretic description of formation of shock wave, 18: 34279 (NP-14186)
CIESLICKI, M. E., Shape forming of refractory metals, 18: 34105
CIFKOVA, Dagmar, Fluorescence of U in melts, 18: 33506
CINDRO, N., Protons from the $Cu^{63}(p,p')Cu^{63}$ reaction, 18: 34862
CINDRO, Nikola, 600-Kilovolt electrostatic accelerator in Split, 18: 34373 (JPRS-25692)
CINOBER, A. B., Similar stagnation-point MHD flow, 18: 34319
CITRON, A., Coulomb scattering in focusing media—FORTRAN programs, 18: 34368 (CERN-64-29)
CITRON, A., Structure in π-p total cross section, 18: 34584
CLARE, D. M., Half life for $Fe^{54}(n,p)Mn^{54}$ reaction, 18: 34885
CLARK, A. R., Spatial accuracy in system of spark chambers, 18: 33924
CLARK, Alfred, Jr., Production and dissipation of magnetic energy by differential fluid motions, 18: 34327
CLARK, Ralph L., Fabrication of vertical-orifice Teflon capillary of Teflon dropping-Hg electrode, 18: 33451 (ORNL-3654)
CLARK, W. E., Conversion of high-level radioactive waste solutions to glassy solids, 18: 35237 (ORNL-3629)
CLARK, W. E., Fixation of high-level radioactive wastes in glassy solids, 18: 35236 (ORNL-3612)
CLARKE, W. B., Isotope anomalies in Xe from meteorites, 18: 34399
CLAUSING, R. E., Method for maintaining very high vacuum, 18: 33764
CLAYTON, Robert N., Oxygen isotope geothermometry, 18: 33785
CLEGG, A. B., Inelastic scattering of 147-Mev protons from C-12, 18: 34816
CLEGG, A. B., Strong magnetic dipole transitions in light nuclei, 18: 34858
CLELAND, W. E., Fine-structure constant from muonium hfs interval, 18: 34921
CLEMENT, F., Study of circulation by an isotopic technique, 18: 33441
CLORFEINE, A. S., Microwave amplification with superconductors, 18: 34714
CLOUGH, W. R., Prog. rpt. on metallurgical studies of Zr and Th, 8/63–7/64, 18: 34053 (TID-20862)
CLOUTIER, G. G., Free-space microwave techniques for plasma measurements, 18: 35020
COCHRAN, W., Interaction of x rays with phonons, 18: 34452
COE, R. J., Yankee. An operating history, 18: 35175
COHEN, B. L., Neutron binding energies in heavy nuclei, 18: 34966
COHEN, M., Planetary physics. V., 18: 34405 (NASA-CR-87)
COHEN, R. C., K_{α} μ-mesic x rays of Ca-40 and Ca-44, 18: 34900
COHN, Mildred, Applications of O-18 to biochemical studies, 18: 33257
COLBURN, D. S., Collision-free MHD shock in interplanetary space, 18: 34393
COLE, Henderson, Dynamical diffraction of x rays by perfect crystals, 18: 34354
COLE, Leonard J., Sensitivity to skin grafts in mice, 18: 33388
COLELLA, A. Conti, Representation of the pancreas by scintigraphy, 18: 33442
COLEMAN, J. A., Radiation damage in Li-drifted p-i-n junctions, 18: 33914
COLEMAN, P. J., Jr., Collision-free MHD shock in interplanetary space, 18: 34393
COLEMAN, Paul J., Jr., Interaction between the interplanetary plasma and the geomagnetic field, 18: 34675
COLLEN, Bengt, Electrolytic separation of Li isotopes, 18: 34009
COLLEN, Bengt, Isotope effects in electrolysis of solid Li hydride, 18: 33536
COLLETT, C. R., Design and performance of ion engine systems, 18: 33699
COLLI, L., New first excited state of P-31, 18: 34818
COLLINS, F. A., Nuclear quadrupole coupling of Cl-35 in Na chlorate, 18: 34301
COLOMBO, R., Elastic properties at high temperature of stainless steel, 18: 34175
COLOMBO, R. L., Solarization and grain growth of sintered UO_2, 18: 34170
COLOMER, J., Measurements in 4π geometry on samples with weak β activity, 18: 33943
COLVIN, R. V., Electrical resistivity of alpha U from 2° to 300°K, 18: 34164
COMMONER, Barry, Civil defense, 18: 33814
COMPTON, W. Dale, Radiation effects in semiconductors, 18: 34216 (NASA-TN-D-2364)
CONCANNON, Joseph P., Construction of complete isodose distributions in Co teletherapy, 18: 33445
CONFORTO, G., Resonance in the dipion mass region 280 to 350 Mev, 18: 34552
CONNOLLY, J. I., Thermal boundary resistance between solids and He below 1°K, 18: 34697
CONNOLLY, P. L., Decay modes and properties of the X^0, 18: 34592
CONNOR, T. R., Recombination of molecular positive ions with electrons, 18: 34259 (AD-434907)
CONRAD, H., Creep of Nb at low temperatures, 18: 34119 (ATN-64(9236)-9)
CONROY, Harold, Molecular Schroedinger equation. III., 18: 34424
CONROY, Harold, Molecular Schroedinger equation. II., 18: 34423
CONROY, Harold, Molecular Schroedinger equation. I., 18: 34422
CONROY, Harold, Molecular Schroedinger equation. IV., 18: 34425
CONSTANTIN, M. J., Radiation-induced pollen sterility, 18: 33313
CONTE, F., Three-body NNΛ force, 18: 34878
CONTI, M., Transistor as logarithmic element, 18: 33836 (RT/EL(64)-5)
CONWAY, John G., Missing band in spectrum of Am^{3+}, 18: 33574
CONZETT, H. E., Polarization of 40-Mev protons, 18: 34550
COOK, G. R., Photoionization and absorption cross sections of H_2 and D_2, 18: 34421
COOKE, W. D., Determination of active H by NMR spectrometry, 18: 33475
COOLEY, Robert N., Weighed gonadal diagnostic x-ray doses, 18: 33419
COOPER, Robert F., Thermonuclear reactions for space propulsion, 18: 34973 (ASD-TDR-63-696)
COPLEY, Stephen M., Plastic deformation of MgO single crystals at elevated temperatures, 18: 34132 (UCRL-11323)
COPLIN, D. H., Uranium dioxide thermal conductivity from irradiations with central melting, 18: 34215 (GEAP-4624)
CORBETT, J. W., New O infrared bands in annealed irradiated Si, 18: 34239
CORENZWIT, E., Resistivity of Mo–Nb and Mo–Re alloys, 18: 34183
CORIELL, Sam R., Trapped trajectories in Brownian motion, 18: 34311
CORIOU, H., Electrorefining of U in molten salt bath, 18: 34093
CORNELL, Anthony, Decomposition kinetics during zone formation in Al–Mg alloys, 18: 34135 (Al-Trans-53)
CORNETT, M. H., Standards for metallographic evaluations of U, 18: 34047 (NLCO-910)
CORNGOLD, Noel, Analysis of pulsed, multiplying systems, 18: 34495 (GA-5404)
COSTA, M., Reaction in two states $^8Li(^8Li,\alpha)^8Be^*$, $^8Be^* = 2\alpha$, 18: 34819
COSTES, Didier, Plug for reactor channel, 18: 35107
COUCHMAN, C. E., III, Cavitation damage in liquid Na, 18: 34075 (NASA-CR-54071)
COURT, G. R., Langmuir probe to measure electron temperatures and densities in afterglows, 18: 34999
COUTSOURADIS, D., Test methods for refractory metals, 18: 34210

COUTURE, Pierre, Separation of U isotopes in France, 18: 34010
COWAN, David L., Fast-passage effects in NMR of Fe-57 in Fe, 18: 33583
COX, J. A., Water-loss test at the LITR, 18: 35222 (ORNL-TM-632)
COX, Joseph R., Many-channel Bargmann potentials, 18: 34532
CRAFT, T. F., Effects of nuclear explosions on watersheds, 18: 33811
CRAIG, H., Isotopic and cosmic chemistry, 18: 33456
CRAIG, Harmon, Relationships in meteorites, 18: 34398
CRAIG, John P., Diagnostics of theta-pinch plasma, 18: 35013
CRAMER, E. M., Self-diffusion studies of delta Pu, 18: 34191
CRAVAROLO, L., Liquid volume fraction in two-phase adiabatic flow, 18: 33732 (EURAEC-1086)
CRAVEN, J. D., Large diurnal variations of trapped and precipitated electrons, 18: 34480
CRAWFORD, Frank S., Jr., Magnetic moment of the Λ, 18: 34580
CRAWFORD, Frank S., Jr., "Radial kinetic energy" term in the Schroedinger equation, 18: 34640
CRAWFORD, J. H., Jr., Radiation effects in Sb-doped Ge, 18: 34238
CRAWFORD, R. B., Determination of total neutron yield from D(d,n)He^3 and T(d,n)He^4 reactions, 18: 34815
CREAGAN, R. J., Yankee. An operating history, 18: 35175
CREUTZ, E., Laminar, turbulent, and transition gas flow in porous media, 18: 33747
CRISCIONE, J. M., High-temperature protective coatings for graphite, 18: 34043 (ML-TDR-64-173(Pt.I))
CRITCHLOW, P. R., Vorticity in liquid He-II, 18: 34691
CROCKER, I. H., Krypton-81 half-life determination, 18: 34881
CROFT, A. J., Hydrogen liquefier at Clarendon Lab., 18: 34689
CROFT, Paul D., Recoil studies of reactions of Ir, Bi, and Pb-208 with O-16, 18: 34782 (UCRL-11563)
CRONIN, J. W., Spatial accuracy in system of spark chambers, 18: 33924
CROZIER, M. H., Zeeman effect of color center in NaCl, 18: 33644
CROZY, A., Investigation of Kr-85 bremsstrahlung sources. V., 18: 34287 (NP-tr-1160)
CSUPKA, Stefan, Contribution to Sr-90 determination in fallout and soil, 18: 33776
CUEVAS, J., Partial stopping powers of H, and He gases for He atoms and ions, 18: 34456
CULLER, Floyd L., Effect of scale-up on fuel cycle costs, 18: 35151 (ORNL-TM-564)
CUMMINGS, R. D., Dependence of H-I curve of Nb–Zr wire on temperature, 18: 34681 (BSD-TDR-64-87)
CUNNINGHAM, J., Complex singularities in production amplitudes, 18: 34524
CUNNINGHAM, John, Properties of the Landau curves, 18: 34668
CURNUTTE, Basil, Jr., Phase-space occupation of electron, proton, and photon beams, 18: 34641
CURTISS, C. F., Quantum corrections to the transport cross sections, 18: 34650
CUTTS, Burton, Nuclear reactor, 18: 35123
CZARNECKI, E. G., Coatings for earth re-entry systems, 18: 34209

D

DAANE, A. H., High-temperature resistivities of Dy, Ho, and Er, 18: 34162
DAGNAC, Rene, Vacuum gages using radioactive sources, 18: 33999
DAHL, Orin I., Additional properties of 959-Mev meson, 18: 34515 (UCRL-11431)
DALGARNO, A., Planetary physics. V., 18: 34405 (NASA-CR-87)
DALSEIDE, Helge, Studies in geomagnetism, 18: 34673
DALY, John Miller, Storage means for radioactive fuel elements, 18: 33725
D'AMATO, F., Somatic mutations in carnations induced by γ rays, 18: 33302
DAMBURG, N. A., Sources of x rays with Sr-90–Y-90 as base, 18: 33989 (AEC-tr-6399(p.243-57))
DAMS, R., Applications of radioisotopes in analytical chemistry, 18: 33483
DANCEWICZ, A. M., Radiation effects on biosynthesis of heme, 18: 33400
DANNER, H. R., Low-frequency motions in isotactic and atactic polypropylene by neutron inelastic scattering, 18: 34265 (BNL-7320)
DAR, A., Elastic scattering and direct nuclear reactions, 18: 34848
DARBY, Paul S., Flat rolling of refractory metals, 18: 34103
DARENSKAYA, N. G., Biological effects and RBE of high-energy protons, 18: 33286 (UCRL-Trans-1068)
DAR'EVA, E. P., Investigation of oxidative destruction of polyamides. II., 18: 33669
DARNELL, A. J., Superconductivity in the artificial metals, 18: 34707
DARWISH, D. A. E., Energy levels of Si-28, 18: 34822
DAS, T. P., Rotational magnetic moment of the H molecule, 18: 34436
DAS GUPTA, K., Recoil electron resonance in crystals and Stokes and anti-Stokes modified lines in x-ray scattering, 18: 35242 (CALT-221-2)
DASHEN, R. F., Magnetic moments of baryons, 18: 34556
DATTA, Sochindra Kumar, Paper chromatographic separation of Th, Zr, and U, 18: 33505
DAVEY, P. G., Scanning and measuring projector, 18: 33957
DAVID (DAVIS), G. Ben, Reactor physics research at Israel Research Reactor, 18: 35218 (IA-892)
DAVIDENKOVA, E. F., Hereditary and chromosomal diseases during analysis of sequelae of radiation, 18: 33336
DAVIDOVA, E., Concentration of O in tissues and its relation to radiosensitivity, 18: 33404
DAVIDOW, R. S., Radiolysis of gaseous HCl, 18: 33625
DAVIES, B., Measurements of Ra in Ra luminizers, 18: 33262
DAVIES, W. E. R., Radiation scattered from plasma, 18: 34348
DAVIS, D. M., Energy response of the ORNL Cutie Pie Chamber to photon radiation, 18: 33883
DAVIS, F. J., Neutron dosimeter utilizing fission foil, 18: 33979
DAVIS, H. T., Transport equation of a Brownian particle, 18: 34349
DAVIS, L., Jr., Collision-free MHD shock in interplanetary space, 18: 34393
DAVIS, Robert L., Knock-off tube as quick pressure release mechanism, 18: 33829 (NOLTR-63-134)
DAVY, J. G., Hydrogen–deuterium kinetic-isotope effect, 18: 33573
DAWSON, Charles, Modified P_3 approximations to neutron transport equation, 18: 34728 (DTMB-1814)
DAY, W. C., Double-moderator DePangher neutron dosimeter, 18: 33951
DAYEM, A. H., Radio-frequency effects in superconducting thin film bridges, 18: 34710
DAYTON, Russell W., Prog. rpt. on civilian applications, 3/64, 18: 34032 (BMI-1668(Del.))
DAYTON, Russell W., Prog. rpt. on civilian applications, 4/64, 18: 34033 (BMI-1669(Del.))
DAYTON, Russell W., Prog. rpt. on civilian applications, 5/64, 18: 34034 (BMI-1672(Del.))
DE AGOSTINO, E., Data recording system for physics experiments, 18: 33837 (RT/EL(64)-8)
DEAN, E. A., Milne problem in finite domain. I., 18: 34746
DEARNALEY, G., Channeling of ions through Si detectors, 18: 33917
DEAVER, Bascom S., Jr., Establishment of the quantized flux state, 18: 34709
DE BAGNEAUX, Charles, Nuclear irradiation enclosure arrangement, 18: 35230
DE BOELPAEP, J., Vapor pressure of H, 18: 33588
DE BOER, Thijs Johannes, Lifetimes of nuclear excited states, 18: 34772 (NP-14184)
DE BRODTKORB, M. K., Determination of radioactivity of minerals by x rays, 18: 33794 (NP-14176)
DE CARVALHO, A. M. Brito, Saturation backscattering of β particles, 18: 35057
DECK, Robert T., Kinematical interpretation of the first π-p resonance, 18: 34581
DE CLERCK, D. H., Applying protective coatings to Nb alloys, 18: 34052 (RTD-TDR-63-4063)
DE CRESCENTE, M. A., Thermal conductivity of UC, 18: 34120 (CNLM-5621)
DE CRESCENTE, M. A., Thermal decomposition of UC, 18: 33523 (CNLM-5619)
DE CRESCENTE, M. A., Thermal decomposition of UN, 18: 33524 (CNLM-5620)
DEFOUW, R. J., Concerning a lunar modulation of geomagnetic activity, 18: 34677
DEGELMAN, L., Point-to-point kernel analysis to determine wall penetration of γ radiation, 18: 35055
DEGENS, Egon T., Oxygen isotope studies on origin of dolomites, 18: 33786
DE HEER, F. J., Excitation of He by protons, 18: 34445
DEIGHTON, Thomas, Improvements in nuclear power plant, 18: 35191
DEILGAT, Edouard, Criticality experiments with annular cylinders containing Pu solutions, 18: 34494 (CEA-R-2495)
DE JONG, M., Effects of telecobalt therapy on the pericardium, 18: 33327
DEJONGHE, M. P., Problems of treatment of radioactive wastes, 18: 35239
DEKA, G. C., Disintegration of emulsion nuclei, 18: 34811
DEKHTYAR, D. Yu., Radioactive instruments for automatization in chemical industry, 18: 33990 (AEC-tr-6399(p.258-76))
DE KLERK, D., Magnetic and caloric effects in a hard superconductor, 18: 34712
DELANG, W., g-Factor of 248 kev state of Se-77, 18: 34895
DELESSERT, Robert, Spurious scattering in photographic nuclear emulsion, 18: 33963
DELFOSSE, J. M., Charge exchange cross sections of Hg and Xe ions in air, 18: 34409
Delgado, F. Palomares
see Palomares Delgado, F.
DELL, John David, Improvements in fuel element assemblies, 18: 35134

DELPEYROUX, Paul, Improvements in reactor fuel element, 18: 35133
DELVES, L. M., Matrix elements of an arbitrary bounded operator, 18: 34021
DELVES, L. M., Upper and lower bounds on generalized Fourier coefficients, 18: 34020
DE MARTINI, F., Noise contribution to line broadening in paramagnetic resonance, 18: 33855
DEMETRIADES, Anthony, Electron fluctuations in plasma, 18: 34981
DEMETRIADES, Anthony, Transient motion of space charge through neutral gas, 18: 34364
DEMICHELIS, F., Disintegration intensity and angular momenta in radioactive decay, 18: 34800
DEMIRTSCHOGLIAN, G. G., Effect of x radiation and H_2O_2 on retina development, 18: 33343
DEMKIN, Yu. I., Dislocations in deformed Mo crystals, 18: 34150
DENILOU, G., Higher power from pool reactors, 18: 35226
DENNY, John P., Production, properties and working of hot-pressed Be billets, 18: 34113
DENOYERS, J., Thermodynamic cycles of nuclear and conventional power plants, 18: 35169
DE SANTIS, V., Leptonic decay of the Ω^- particle, 18: 34587
DE SAUSSURE, G., Ratio of capture-to-fission in U-235, 18: 34886
DE SEGOVIA, J. L., Effects of electron-surface interaction in ionization gages, 18: 33759 (AD-427830)
DESHPANDE, K. B., Retardation factors for ion exchange columns, 18: 33684
DE SOBRINO, L. G., Kinetic equation for homogeneous plasma in uniform magnetic field, 18: 35037
DE SORBO, Warren, Ratio H_{c_3}/H_{c_2} in superconducting Nb and Nb–O solutions, 18: 34704
DETENBECK, Robert W., Unscrambling pulse-height spectra on-line, 18: 33925
DETERT, K., Decomposition kinetics during zone formation in Al–Mg alloys, 18: 34135 (Al-Trans-53)
DETERT, Klaus, Kinetics of decomposition of Al–Mg alloys, 18: 34244
DETTMAR, P., Effect of x radiation and H_2O_2 on retina development, 18: 33343
DE VAULT, G. P., Eigenfunctions of Boltzmann collision operator, 18: 34331
de Viedma Alonso, Luis Garcia
see Garcia de Viedma Alonso, Luis
DE VILLIERS, J. A. M., Relative light output of plastic scintillators, 18: 33638
DEVISHEV, M. I., Shower efficiency of spark chamber, 18: 33966
DEVONS, S., K_α μ-mesic x rays of Ca-40 and Ca-44, 18: 34900
DEVYATKO, Yu. N., Vibration-rotational interaction in deformed nuclei, 18: 34950
DEWITT, Warren P., Determining Rn concentration in air near ground, 18: 34257
DE ZERTUCHA, J., High-activity dusts isolated in fallout, 18: 33770 (SCPRI(S)-99)
DICKERMAN, C. E., Coherence of failure for hypothetical meltdown accidents in EBR-II-like reactor, 18: 35059 (ANL-6844)
DICKERSON, Ronald F., Prog. rpt. on civilian applications, 3/64, 18: 34032 (BMI-1668(Del.))
DICKERSON, Ronald F., Prog. rpt. on civilian applications, 4/64, 18: 34033 (BMI-1669(Del.))
DICKERSON, Ronald F., Prog. rpt. on civilian applications, 5/64, 18: 34034 (BMI-1672(Del.))
DICKINSON, W. S., Analysis of tower flooding with scintillation counter and Cs source, 18: 34000
DICKSON, David T., Martensitic transformation in alloy steel, 18: 34133 (UCRL-11388)
DICKSON, Samuel A., NMR in solid H_2 and D_2 under high pressures, 18: 34260 (AD-601933)
DIETRICH, K., Nuclear structure calculations for deformed nuclei, 18: 34781 (UCRL-11376)
DIETZ, K., Bootstrapping of vector mesons, 18: 34557
DIEZ GONZALEZ, R., Interactions of low-energy deuterons with V-51, 18: 34758 (JEN-130-DF/I-41)
DILLINGER, J. R., Thermal resistance at In–sapphire boundaries, 18: 34699
DIMITROV, Omourtague, Restoration of electrical resistivity of irradiated Al, 18: 34222
DINTER, H., Gamma spectroscopy in decay $Mn^{56} \rightarrow Fe^{56}$, 18: 34840
DIONISIO, Jose Sant'ana, Low-energy electron spectra. II and III., 18: 34786
DIXIT, R. M., Preparation of $Cs_2UO_2(NO_3)_4$, 18: 33547
DLOUHA, Jarmila, Mössbauer effect, 18: 34298
DMITRIEVA, H. (G.) P., Crystal structure of Nb–Co β phase, 18: 34145
DOAR, J. F., Preparation of graphites for irradiation, 18: 34041 (HW-80752
DOBBERTIN, Rolf, Distribution functions of charged particle system, 18: 34415
DOBROV, N. N., Radiation safety in flights of Soviet cosmonauts, 18: 33815
DODD, John Alan, Nuclear reactors, 18: 35086
DODGE, W. R., Anomaly in response of semiconductor detectors, 18: 33916
DOEDERLEIN, J. M., BIGG-I—multigroup neutron spectrum and criticality code, 18: 34730 (KR-77)
DOLGOSHEIN, B., Streamer chamber, 18: 33965
DOLGOV, E. G., Changes in sorption properties of rat adrenal tissues after irradiation, 18: 33357
DOLPHIN, G. W., Body content following inhalation of Pu, 18: 33260
DOLPHIN, G. W., Determination of Pu body burdens, 18: 33267
DOMEN, S. R., Anomaly in response of semiconductor detectors, 18: 33916
DOMOKOS, G., Bootstrapping of vector mesons, 18: 34557
DOMSHLAK, M. P., Biological effects and RBE of high-energy protons, 18: 33286 (UCRL-Trans-1068)
DONAGHY, J. J., Positron annihilation in divalent metallic oxides, 18: 33605
DORMAN, L. I., Cosmic rays, 18: 34461 (NASA-TT-F-126)
DORMAN, L. I., Coupling coefficients for primary and secondary variations of cosmic rays, 18: 34471 (NASA-TT-F-126(p.265-72))
DORMAN, L. I., Coupling coefficients between primary and secondary variations of cosmic rays, 18: 34472 (NASA-TT-F-126(p.273-9))
DORMAN, L. I., Integral multiplicity of μ-meson production in earth's atmosphere, 18: 34470 (NASA-TT-F-126(p.230-64))
DORMAN, L. I., Introducing meteorological corrections into cosmic-ray intensity data, 18: 34466 (NASA-TT-F-126(p.194-214))
DORMAN, L. I., Meteorological cosmic-ray effects below ground, 18: 34468 (NASA-TT-F-126(p.220-3))
DORMAN, L. I., Variations of cosmic rays, 18: 34462 (NASA-TT-F-126(p.2-80))
DOROKHOV, V. I., Reactions of $MoSi_2$ with Be, 18: 34149
DOUGAL, Arwin A., Diagnostics of theta-pinch plasma, 18: 35013
DOUGLAS, Jim, Jr., Determination of diffusivity of isotropic medium, 18: 34018
DOWLEY, M. W., Field energy removal from a superconducting solenoid, 18: 34690
DOYLE, N. J., Constitution diagram of Nb–Hf, 18: 34163
DRELL, S. D., Asymmetric μ-pair photoproduction at small angles, 18: 34594
DRESSLER, Jacques Henri, Nuclear fuels, 18: 35138
DROBIZ, A. M., Radioactive liquid analyzer, 18: 33473 (AEC-tr-6399 (p.115-23))
DROSTE, C., Reactions (p,α) to N = 28 nuclei, 18: 34855
DRUMMOND, W. E., Nonlinear plasma oscillations, 18: 34523
DRUZHININ, Yu. P., Proteolysis of blood of irradiated rats, 18: 33362
DUBONOSOV, T. S., Application of radiations in hydroponics, 18: 33997
DUBOULOZ, P., Metabolism of lipidic peroxides. II., 18: 33236 (ANL-Trans-54)
DUBROVIN, M. M., Meteorological cosmic-ray effects below ground, 18: 34468 (NASA-TT-F-126(p.220-3))
DUCK, Ian, Angular distributions in C-12 $\rightarrow 3\alpha$, 18: 34868
DUCKWORTH, W. H., Refractory ceramics of interest in aerospace structural applications, 18: 34129 (RTD-TDR-63-4102(Suppl.1))
DUCROS, R., Secondary emission statistics, 18: 33911
DUERDOTH, I. P., Diffraction in nuclear resonant scattering, 18: 34929
DUFAURE DE LA ARTE, Stephane Joseph, Nuclear fuels, 18: 35138
DUKE, E. E., Waste gas handling. System for 300-Mw BWR, 18: 35181
DUL'KOVA, L. S., Elastic scattering of protons by H-3, 18: 34944
DUNN, D. A., Computer model of beam-generated plasma, 18: 35044
DUNNING, J. R., Jr., Electroproduction of protons at 1 and 4 Bev, 18: 34916
DUPLAN, J.-F., Effects of hydrocortisone and x irradiation on leukemogenesis, 18: 33311
DUPLAN, J. F., Radiation effects on hemopoietic function, 18: 33344
DUPLISHCHEVA, A. P., Effect of dysentery and staphylococcus bacteria on immunity of irradiated animals to typhoid bacteria, 18: 33369
DUPONT, Georges, Nuclear irradiation enclosure arrangement, 18: 35230
DU PONT, P. S., Syncom 2 electrical power system, 18: 33700
DUPUY, P., Influence of culture conditions on radiation resistance of some lactobacilli, 18: 33293
DUQUESNOY, Alain, Equilibrium U_4O_9–U_3O_8, 18: 33546
DURAND, Roger, Niobium: metal of the future, 18: 34189
DURANT, W. S., Trapping of I by active charcoals, 18: 33808 (AEC-tr-6459)
DURASOVA, S. A., Proton resonance in UO_4 hydrates, 18: 33602
DUTREIX, Andree, Physical basis of radiotherapy and radiobiology, 18: 33228
DUTREIX, Jean, Physical basis of radiotherapy and radiobiology, 18: 33228
DUTTA, A. K., Nuclear binding energies, 18: 34812

DUTTON, J., Diffusion and drift of positive ions in Ne, 18: 34449
DVORAK, Robert F., Low-background α scintillation counter, 18: 33933
DVORETSKII, V. N., Multiple scattering of 75- to 200-kev protons in solids, 18: 34943
DWYER, Kenneth R., Cerium-144 and Cs-137 in wheat, 18: 33818
DYCE, I. H., Corrosion of Zy fuel cladding, 18: 34082
DYER, A. J., Study of trivalent-pentavalent oxide systems, 18: 34199
DYMKOV, Yu. M., Hard bitumen in U-bearing veins, 18: 33795
DYOS, M. W., Theorem concerning slowing-down equation, 18: 34747
DYSTHE, Kristian Borstad, Invariance of the action integral, 18: 34293
DZHELEPOV, V. P., Catalysis of d + d → He^3 + n fusion reaction by μ^-, 18: 34617

E

EAKINS, J. D., Role of fecal analysis in a bio-assay program, 18: 33266
EASTWOOD, T. A., Automatic sample changer for α-, β-, and γ-active sources, 18: 33716
EASTWOOD, T. A., Krypton-81 half-life determination, 18: 34881
EATON, C. F., Transient solution of the Fokker-Planck equation, 18: 34457
EBERHARDT, A., Lead of volcanic origin, 18: 33791
ECKHAUSE, M., Fine-structure constant from muonium hfs interval, 18: 34921
EDELBAUM, T. N., Applications of SNAP-50 class powerplants, 18: 35211
EDGERLEY, E., Jr., Treatment of Sr-90-bearing organic waste by ion exchange, 18: 35240
EDLUND, Milton C., Neutronic reactor, 18: 35233
EDMONDS, P. H., Near-resonance charge transfer process, 18: 34448
EDVARDSSON, K-A, Prog. rpt. on personnel dosimetry, annual, 1963, 18: 33798 (AE-147)
EDWARDS, R. N., Prog. rpt. on switchgear for space electrical system, 1/16–4/16/64, 18: 33828 (NASA-CR-54059)
EDWARDS, W. T., Corrosion treatment for cooling water circuits, 18: 35063 (IG-Report-52)
EFENDIEV, G. Kh., Reactions of Ce and Ga selenides, 18: 33552
EGOROV, A. I., Preparation of pure U salts, 18: 33599
EGOROV (YEGOROV), Yu. A., Counters and dosimeters for studying shielding and protective properties of materials, 18: 33886 (JPRS-25467 (p.9-24))
Eguiluz, J. C. Petrement
see Petrement Eguiluz, J. C.
EHRLICH, Gert, Modern methods in surface kinetics, 18: 33454
EICHELBERGER, J. F., Prog. rpt., 4/64, 18: 35246 (MLM-1196)
EICHLER, Eugene, Survey of some properties of even-even nuclei, 18: 34933
EICK, H. A., Vapor pressure of Np, 18: 33570
EISEN, F. H., Electron radiation damage in InSb, 18: 34240
EJIRI, Hiroyasu, Numerical differential cross sections of $Ca^{40}(p,d)Ca^{39}$ at 55 Mev, 18: 34757 (INSJ-72)
EKSTIG, Boerje, X-ray L-emission bands of 46 Pd–52 Te, 18: 34410
EKSTIG, Boerje, X-ray $L\gamma_4$ emission band of 48 Cd, 18: 34411
EL-BAZ, E., Calculation of (n,α) angular distributions, 18: 34876
ELBERG, S., Measurement of viscosities at temperatures to 500°C and pressures to 200 kg/cm², 18: 33858
ELBERG, Solomon, Improvements in measuring rate of flow of liquid, 18: 33871
ELEY, D. D., Advances in catalysis. XIV., 18: 33453
ELGIN, Dean J. C., Prog. rpt. on lattice and electronic defects in solids, final, 6/64, 18: 34280 (NYO-2680-1)
ELISEEV, S. M., Interaction of cosmic particles with nuclei, 18: 34764 (JINR-P-1678)
ELKIND, Sidney, Radiation-cooled nuclear rocket nozzle, 18: 33707
ELLETT, W. H., Cesium-137 fallout in muscle samples, 18: 33427
ELLIOTT, R. J., Infrared absorption of H^- and D^- ions in CaF_2, 18: 34262 (AFCRL-64-284)
ELLIOTT, R. J., Magnetic ordering in heavy rare earth metals, 18: 34188
ELLIS, Thomas G., Phase equilibria and crystallography for Nb–Sn, 18: 34165
EL-NADI, L. M., Energy levels of Si-28, 18: 34822
EL-NADI, M., Direct interaction in heavy ion reactions, 18: 34856
ELREFAI, Ard El Monem H., Studies on N-fixing blue-green algae. II., 18: 33237
ELSTON, Jean, Recovery energy of BeO irradiated with neutrons, 18: 34227
EL-TANTAWY, Y. A., Cerium(IV)–oxalate reaction in acidic sulfate media, 18: 33537
ELTON, L. R. B., Form factors for medium and heavy nuclei, 18: 34928
ELY, Robert P., Analysis of $K^+_{\mu 2}$ decays, 18: 34519 (UCRL-11549)
EL-ZAIKI, M. I., Reaction $Al^{27}(d,\alpha)Mg^{25}$ at 1.5 to 2.6 Mev, 18: 34823
EMILIANI, C., Paleotemperature analysis of fossil shells of marine mollusks, 18: 33784
ENDOW, J. S., Properties of I^{131}-labeled iodobenzoic acids, 18: 33614
ENDOW, N., Prog. rpt. on sorption of gases on metal surfaces in vacuum, 2/15–5/15/64, 18: 34282 (TID-20837)
ENG, Ken Y., Determination of C in Na, 18: 33477
ENGE, H. A., Shell-model states in Ca-49, 18: 34905
ENGELS, W., g-Factor of 248 kev state of Se-77, 18: 34895
ENIKEEV, M. I., Protection in I-131 therapeutic application, 18: 33421
EPSTEIN, H. M., Detection and identification of nuclear bursts, 18: 34251
EPSTEIN, M. A., Review of experimental pathology. Vol. II., 18: 33229
EPSTEIN, Samuel, Oxygen isotope studies on origin of dolomites, 18: 33786
EPSTEIN, Samuel, Oxygen isotope analyses of tektites, soils, and impactite glasses, 18: 33787
ERGEN, W. K., Effect of two temperature coefficients of reactivity, which result from segregation of fuel, 18: 35114 (ORNL-tr-263)
ERICKSON, W. H., Hydrogen embrittlement of some Zr alloys, 18: 34169
ERMAN, P., K Auger group intensities in Cl-37, 18: 34789
ERMAN, P., K Auger effect in Br-79, 18: 34788
ERMOLOV, P. F., Catalysis of d + d → He^3 + n fusion reaction by μ^-, 18: 34617
ERSHLER, B. V., Spectrometric determination of microquantities of B in materials, 18: 33479
ESIKOV, V. I., Critical boiling heat transfer, 18: 33743
ESPI, G., Transistorized fast pulse amplifier, 18: 33861
ESTERLING, Robert John, Muon-capture rate in He-3 and He-4, 18: 34776 (UCRL-11004)
ESTULIN, G. V., High-temperature oxidation of Nb alloyed with Ti and Mo, 18: 34079
EUROLA, Tapio, Reactor noise experiments on Halden BWR, 18: 35157 (TID-7679(p.449-68))
EVANS, John E., Auroral measurements, 18: 34672
EYRAUD, Charles, Trajectories of sub-micronic particles in ionized fields, 18: 34314
EYRAUD, Lucien, Recovery energy of BeO irradiated with neutrons, 18: 34227
EZAWA, Hiroshi, Canonical variables as limit of infinite space volume, 18: 34653

F

FABBRI, E., Activation analysis of D by $C^{13}(d,n)N^{13}$ reaction, 18: 33486
FABRY, Jean, Niobium: metal of the future, 18: 34189
FAES, M. H., Decontamination of the skin, 18: 33812
FAESSLER, A., Collective g factor in deformed nuclei, 18: 34939
FAESSLER, Amand, Coriolis anti-pairing and blocking effects in deformed even-even nuclei, 18: 34775 (TID-20875)
FAHLMAN, A., Double-focusing β spectrometer (50 cm), 18: 33947
FAHMY, H., Polarization phenomena in deuteron stripping reactions, 18: 34861
FAINBERG, L. I., Radioactive density meter, 18: 33848 (AEC-tr-6399 (p.138-52))
FAIRBAIRN, W. M., Finite and disconnected subgroups of SU_3, 18: 34529
FAISSNER, H., Cluster model of nuclear fission. I., 18: 34872
FALCOZ, A., High stability multiparametric modular circuitry at Saclay's cyclotron, 18: 33936
FAN, C. Y., Evidence for >30-kev electrons accelerated in earth's magnetospheric boundary, 18: 34680
FAN, Ts'un-yi, Preparation of Mo single crystals, 18: 34061 (FTD-TT-64-350)
FANNING, L. E., Liquid scintillation solvent systems, 18: 33938
FARRELL, John, Magnetic characteristics of CeF_3, 18: 34156
FARRIOR, Richard T., Primary reconstruction of cervical esophagus, 18: 33219
FARROW, E. F., Search for low-lying ½⁺ level in B-9, 18: 34892
FAUSTO, N., Metabolic alterations after total-body doses of x radiation, 18: 33294
FAVREAU, Claude, Improvements in measuring rate of flow of liquid, 18: 33871
FAYOLLE, Jean-Claude, Development of new nuclear emulsions of high sensitivity, 18: 33962
FEDER, H. M., Role of coprecipitation in alloy partition during crystallization, 18: 34192
FEDEROV, G. B., Strength and diffusion characteristics of Zr, 18: 34153
FEDOROV, G. B., Penetration of U from U–Nb–Zr alloy into Mo by diffusion, 18: 34174
FELDMAN, Martin, Photomultiplier transit times, 18: 33961
FELLER, H. G., Grain growth of Zr, Zy-2, and Ti, 18: 34139
FENESH, T., Alpha spectra of Tb isotopes, 18: 34766 (JINR-P-1687)
FENG, Tuan, Preparation of Mo single crystals, 18: 34061 (FTD-TT-64-350)

FENIN, Yu. I., Scattering length and cross section for neutron radiative capture, 18: 34762 (JINR-P-1671)
FENYVES, E., Inelastic two-prong π^--p interactions, 18: 34520
FERGUS, Richard W., Low-background α scintillation counter, 18: 33933
FERRARA, G., Lead of volcanic origin, 18: 33791
FERREBEE, J. W., Bone marrow aspiration in mice, 18: 33223
FERRINI, Umberto, Inactivation of lysozyme following uv irradiation, 18: 33295
FERRIS, L. M., Processing graphite reactor fuels, 18: 33687
FERRY, J. A., Detailed forms of yield curves from semi-thick Al targets, 18: 34917
FESHBACH, H., Intermediate resonances and doorway states, 18: 34768 (MIT-2098-61)
FESSENDEN, Richard W., g Factor of H atoms trapped in phosphates, 18: 33645
FETKOVICH, J. G., Low-temperature seals for plastic windows, 18: 34685
FICHTEL, C. E., Modulation of low-energy galactic cosmic-ray H and He, 18: 34482
FIDIAM, J. F., Electron drift-velocity detector, 18: 33476
FIELDS, T. H., Low-temperature seals for plastic windows, 18: 34685
FIERMANS, L., Dislocations in Si single crystals using white x radiation, 18: 34186
FIL'CHENKOV, V. V., Catalysis of $d + d \rightarrow He^3 + n$ fusion reaction by μ^-, 18: 34617
FILIPPAS, T. A., Velocity of γ rays from a moving source, 18: 34659
FILOV, R. A., Spectrum of α particles in Cm-244 spontaneous fission, 18: 34955
FIMPLE, W. R., Applications of SNAP-50 class powerplants, 18: 35211
FINEGOLD, Leonard, Germanium telluride, 18: 34711
FINGER, Harold B., Survey of space nuclear propulsion, 18: 35216
FINK, Richard D., Hot H displacement reaction with osobutane, 18: 33640
FINKEL', V. A., Deformation and fracture of rolled Be, 18: 34140
FIOLETOVA, A. F., Determination of S in Be, Zr, Nb, and their oxides, 18: 33513
FIORONI, F., Automatic counting scaler, 18: 33884 (RT/EL(64)-7)
FIRSOVA, E. V., Heat transfer between separated bunches of rods with longitudinal flow of metallic Na, 18: 33744
FISCHER, Gaston, Microwave surface impedance of a periodic medium, 18: 34656
FISCHER, Gaston, Microwave surface impedance of superconductors of the second kind, 18: 34705
FISCHER, Jan, Green's functions, 18: 34648
FISCHER, Joseph, Apparatus for determination of H content in Ti and Zr, 18: 33511
FISHER, D. J., Developments in d-c polarography, 18: 33452 (ORNL-P-145)
FISHER, G. P., Search for CP nonconservation in K_2^0 decays, 18: 34590
FISHER, Shalom, Stability and oscillation analysis of magnetic mirror systems, 18: 34979 (UCRL-11077)
FITE, Lloyd E., Automatic systems for biologic nuclear activation analyses, 18: 33464 (NASA-CR-52997)
FIZZOTTI, C., Influence of rate cooling from γ phase on U alloys, 18: 34127 (RT/MET(64)-2)
FLAHERTY, W. J., Multicomponent tubular UO_2 fuel element irradiations, 18: 35129 (HW-80291)
FLAMMERSFELD, A., K ionization through electron and positron ions, 18: 34431
FLAUGER, W., Lifetime of 37-kev level of Br-80, 18: 34845
FLAX, Lawrence, Magnetic field from finite thin cone, 18: 34273 (NASA-TN-D-2400)
FLEISCHER, R. L., Prog. rpt. on superconducting properties of materials, 12/15/63–6/15/64, 18: 34683 (NP-14136)
FLITCROFT, N., Infrared spectra of $(CO)_5$ Mn–Re$(CO)_5$, 18: 33551
FLODMARK, Stig, Electronic energy bands for Zr–O crystals. I., 18: 33543
FLORES, J. Merlo, Thick junctions made with nuclear-compensated Si, 18: 33920
FLOWERS, B. H., Pairing correlations in finite systems. II., 18: 34927
FLOWERS, Herschel H., Effects of x irradiation on cottonmouth moccasin, 18: 33385
FLYNN, K. F., Helium-ion-induced fission of Pb^{206} and Bi^{209}, 18: 34880
FODERARO, A., Point-to-point kernel analysis to determine wall penetration of γ radiation, 18: 35055
FODERARO, A., Sudden atmospheric ionization in regions shadowed from high-altitude nuclear bursts, 18: 34252
FOGEL, Marian, Forssman-antigen synthesis in hamster and mouse cells, 18: 33317
FOLTZ, J. R., Method of reproducing UO_2 reactor fuel, 18: 33692
FOMENKO, A. S., Investigation of oxidative destruction of polyamides. II., 18: 33669
FOMICHEV, V. A., Ratio of cross sections for formation of isomer pair Sc-44, 44m, 18: 34948
FOMIN, Yu. A., Energy spectrum and composition of cosmic rays of galactic and metagalactic origin, 18: 34491
FOMUSHKIN, E. F., Photoneutron spectra from Pt, Bi, Pb, and U, 18: 34945
FONDARAI, J., Metabolism of lipidic peroxides. II., 18: 33236 (ANL-Trans-54)
FONG, Francis K., Color centers of alkaline-earth halides, 18: 33643
FONG, Francis K., Stable divalent rare earths in alkaline earth halides, 18: 33589
FONTAINE, G., Portable plant for decontamination of buildings and equipment, 18: 33800 (EUR-1821.f)
FOOTE, J. K., Uranyl-photosensitized reaction with tetrabutylammonium iodide, 18: 33628
FOOTE, R. S., High-speed decade pulse counting, 18: 33956
FORD, J. L. C., Jr., Nuclear resonance and Coulomb excitation in $Na^{24}(p,p')$ reaction, 18: 34836
FORRESTER, A. T., Electron bombardment and contact ion engines, 18: 33698
FORSBLOM, I., Investigation of reaction $K^{39}(p,\gamma)Ca^{40}$ at 1103, 1131, and 1153 kev, 18: 34784
FORSEN, Sture, Analysis of high-resolution NMR spectra, 18: 34309
FORTESCUE, Peter, Fuel element, 18: 35136
FORTI, Guido, Resonance integrals in homogeneous and heterogeneous systems, 18: 34741
FORTI, P., New first excited state of P-31, 18: 34818
FORTNEY, R. E., Computer analysis of radiation shielding, 18: 35048 (AMRL-TDR-64-11)
FOSTER, Robert E., Adsorption of young fission products on various surfaces, 18: 33448 (IDO-14644)
FOU, C. M., Levels in Sc-42 from $Ca^{40}(He^3,p)Sc^{42}$, 18: 34960
FOWLER, R. G., Shock reflection in high-explosive shock tube, 18: 34332
FOWLER, William A., Abundances of U and Th in solar system, 18: 34401
FOX, C. F., Enzymatic synthesis of RNA. I., 18: 33243
FOX, C. F., Enzymatic synthesis of RNA. II., 18: 33244
FOX, C. F., Enzymatic synthesis of RNA. III., 18: 33245
FOX, J. G., Velocity of γ rays from a moving source, 18: 34659
FRAAS, A. P., Service machine for gas-cooled reactors, 18: 35106
FRADKIN, D. M., Biedenharn symmetric Dirac-Coulomb Hamiltonian, 18: 34576
FRANK, L. A., Large diurnal variations of trapped and precipitated electrons, 18: 34480
FRANTTI, G. E., Discrimination of seismic signals from earthquakes and explosions, 18: 33765 (AD-437784)
FRANZETTI, Franco, Nuclear irradiation enclosure arrangement, 18: 35230
FRASER, J. S., Monte Carlo calculation of neutron production in heavy element targets by protons in range 0.3 to 1 Bev, 18: 34961
FRATANTUNO, Joseph, Apparatus for measuring radioactivity of liquid samples, 18: 33982
FRAUDE, Axel, Effect of two temperature coefficients of reactivity, which result from segregation of fuel, 18: 35114 (ORNL-tr-263)
FRAUMENI, Joseph F., Jr., Cancer mortality among underground metal miners, 18: 33813
FREEDMAN, M. S., Electron response of NaI(Tl), 18: 33902
FREEMAN, A. J., Quadrupole antishielding factors for rare-earth ions, 18: 34442
FREEMAN, Gordon R., Radiolysis of cyclohexanone. I., 18: 33623
FREEMAN, Gordon R., Radiolysis of cyclohexanone. II., 18: 33624
FREIER, P. S., Hydrogen isotopes produced in solar flares, 18: 34382 (NP-14141)
FRENKEL, A., Inelastic two-prong π^--p interactions, 18: 34520
FREUND, Peter G. O., Mass and coupling constant formulas in broken symmetry schemes, 18: 34589
FREY, Wolfram, Radiation measuring apparatus, 18: 33975
FREYCENON, J., Harmonic analysis of instantaneous counting rate of periodically sampled flow of pulses, 18: 35079 (TID-7679(p.331-4))
FRIEDEL, Jacques, Impact of quantum mechanics on physical metallurgy, 18: 34066
FRIEDLANDER, Gerhart, Nuclear and radiochemistry, 18: 33455
FRIEDLANDER, S. K., Prog. rpt. on behavior of aerosols, final, 7/64, 18: 33806 (NYO-10715)
FRIEDMAN, H. A., Phase equilibria in NaF–BeF_2–ThF_4 system, 18: 33582
FRIEDMAN, Irving, Deuterium content of phenocrysts, 18: 33788
FRIEDMANN, H., Self-diffusion coefficients and quantum equilibrium properties, 18: 34307
FRIEDRICHS, K. O., Method for confining plasma, 18: 35047
FRIGERIO, G., Fission gas release from UO_2, 18: 34214 (EURAEC-1126)
FRIML, M., Catalysis of $d + d \rightarrow He^3 + n$ fusion reaction by μ^-, 18: 34617
FRISCHAUF, H., Trace element content of leukocytes by neutron activation analysis, 18: 33517
FRITZ, J. R., Tests on EVESR MK I fuel bundle, 18: 35144 (GEAP-4560)
FROEMAN, Anders, Penetration effects in ^2F series of CsI, 18: 33579

FROEMAN, Per Olof, Equation of state of ideal non-relativistic Fermi-Dirac gas, 18: 34645
FROIS, Colette, Restoration of electrical resistivity of irradiated Al, 18: 34222
FROLOV, G. V., Fermion Regge poles in processes involving vectons, 18: 34620
FROMM, E., Niobium–gas systems, 18: 34177
FROMM, Jacob E., Heat transfer in von Karman wake of rectangular cylinder, 18: 33748
FRONTEAU, J., Coulomb scattering in focusing media—FORTRAN programs, 18: 34368 (CERN-64-29)
FRY, D. N., Negative reactivity measurement by neutron fluctuation analysis, 18: 35074 (TID-7679(p.171-81))
FUENFER, E., Spectral distribution of light scattered by a θ-pinch plasma, 18: 35010
FUHS, Allen E., Turbulence in arc plasma jet, 18: 35040
FUJII, Masamichi, Microangiography as a technique, 18: 33289
FUJII, T., Magnitude of the K_1^0–K_2^0 mass difference, 18: 34593
FUJITA, Haruyuki, Backscattering of γ rays from Fe slabs, 18: 35054
FUKUDA, Nobuyuki, Linearized many-body problem, 18: 34342
FUKUI, Kenichi, Radiation-induced polymerization of 3,3-bis-chloromethylcycloxabutane, 18: 33651
FULTON, T., Finite and disconnected subgroups of SU_3, 18: 34529
FUNCK-BRENTANO, J.-L., Physicochemical form of radioelements, 18: 33590
FUNSTON, E. S., Preparation of high-purity BeO powder, 18: 34064
FUQUAY, James J., Ground-level air exposures resulting from emissions from stacks at Hanford, 18: 33801 (HW-80204)
FURMAN, E. G., Investigation of oxidative destruction of polyamides. II., 18: 33669
FURNICA, G., Radiochemical analysis of urine, 18: 33519
FURROW, C. L., Radiation-induced polymerization-modification of acrylonitrile, 18: 33650
FURROW, M., Jr., Power system for manned earth orbital space station, 18: 33719
FURUKAWA, Y., Colored multiscintigram system, 18: 33968

G

GABUDA, S. P., Proton resonance in UO_4 hydrates, 18: 33602
GADIOLI, E., New first excited state of P-31, 18: 34818
GAGARINSKII, Yu. V., Proton resonance in UO_4 hydrates, 18: 33602
GAISCH, H., Effect of γ radiation on *Saccharomyces cerevisiae*, 18: 33393
GAJEWSKI, Ryszard, Introduction to plasma theory, 18: 35029
GAJEWSKI, Ryszard, Plasma waves, 18: 35030
GAJEWSKI, Ryszard, Problems in magnetogasdynamics. I., 18: 35028
GALBRAITH, W., Structure in π-p total cross section, 18: 34584
GALERY, L., Top concrete shield for EDF-1, 18: 35167
GALINA, A. A., Investigation of oxidative destruction of polyamides. II., 18: 33669
GALLAGHER, C. J., Jr., Two-quasiparticle $K\pi = 0^-$ states in deformed even-even nuclei, 18: 34907
GALLEY, Robert, Separation of U isotopes in France, 18: 34010
GALLIEN-LARTIGUE, O., Effect of erythropoietin upon heme synthesis by marrow cells, 18: 33242
GAMBILL, W. R., Studies of boiling burnout, 18: 33737 (ORNL-P-18)
GAMBILL, W. R., Subcooled swirl-flow boiling and burnout, 18: 33738 (ORNL-TM-894)
GANGULY, P., Nuclear binding energies, 18: 34812
GANZHA, V. D., Ion-exchange unit for production of reactor feed water, 18: 33713
GARCIA DE VIEDMA ALONSO, Luis, "Syrio" program for calculation of matrix inverse, 18: 34016 (JEN-122-DF/I-38)
GARCIA-MUNOZ, M., Partial stopping powers of H, and He gases for He atoms and ions, 18: 34456
GARDENINA, A. P., Investigation of oxidative destruction of polyamides. I., 18: 33668
GARDIOL DE BERTOLA, V., Colpocytological variations related with radiations, 18: 33348
GARDNER, W. J., Method of reproducing UO, reactor fuel, 18: 33692
GARRETT, Patricia E., Neutron surface multiplications of transport containers, 18: 34726 (AWRE-O-21/64)
GARY, Ronald K., Treatment of postirradiationally recidivated cancers of the cervix uteri, 18: 33444
GASANOV, G. I., Role of oleic acid oxidation products in cellular radiation injury, 18: 33390
GASSER, E. R., Experimental gas cooled reactor safety analysis, 18: 35163 (TID-20890)
GAT, J. R., Pre-enrichment of tritium for low-level counting, 18: 34011
GATTO, R., Strangeness-violating vector currents, 18: 34596
GAUSE, R. L., Effects of radiation on engineering materials, 18: 34247
GAUSSENS, M. J., Economic aspects of natural U nuclear power plants, 18: 35170
GAUTHIER, R. V., Photon scintillator, 18: 33908
GAVORET, J., Perturbation expansion for Bose liquid at zero temperature, 18: 34686
GAVOSTO, F., Labeling of chromosomes of human leukemia cells, 18: 33253
GAY, J. G., Lower bound procedure for energy eigenvalues, 18: 34660
GAZZOLA, Adriano, Use of nuclear products in study of atmospheric movements, 18: 34255
GEBAUHR, W., Activation analysis of high-purity Si, 18: 33502
GEBHARDT, E., Niobium–gas systems, 18: 34177
GEBHARDT, E., Physical properties of refractory metals, 18: 34205
GEEVER, Erving F., Effect of D_2O on wound healing, collagen, and metabolism, 18: 33250
GEIDEMAN, W. A., Jr., Development status of low-power arc-jet engines, 18: 33705
GELLER, Edward, Intrascintillation vial reaction tube, 18: 33478
GEMMELL, D. S., Particle discrimination by time-of-flight methods, 18: 33932
GENDREAU, G., Storage rings for electrons, 18: 34370 (LAL-1110)
GENS, T. A., Gas-phase reduction of UCl_4 to UCl_3 with CO, 18: 33530 (ORNL-TM-829)
GENS, T. A., Processing graphite reactor fuels, 18: 33687
GENTRY, W. O., Development of refractory metal alloys, 18: 34069
GEORGE, S., Ligand field spectra of some new laser chelates, 18: 33565
GERASIMOV, A. F., High-temperature oxidation of Nb–Mo–Cr alloy, 18: 34080
GERBER, L. M., Gamma relays for drops in radiation intensity, 18: 33846 (AEC-tr-6399(p.30-42))
GERE, E. A., High-speed analog pulse divider, 18: 33929
GERECKE, G. E., Prog. rpt. on converter for nuclear thermionic energy source, final, 5/3–12/3/63, 18: 34497 (NP-12888(Vol. 5))
GERETH, R., Radiation damage in Si avalanche diodes, 18: 34248
GEREVINI, T., Fission gas release from UO_2, 18: 34214 (EURAEC-1126)
GERHART, J. M., Valve for control of streams of powdered solids, 18: 33712 (HW-53440)
GERLING, E. K., Age of Ni-bearing pluton with K–Ar and Rb–Sr methods, 18: 33781
GERRITSEN, G., Suppression of nuclear dynamic polarization, 18: 34334
GERSCH, H. U., Comparison of (n,γ) and (d,p) reaction in Co, 18: 34827
GERSTEIN, I. S., Equivalence of elementary and composite particles, 18: 34522
GERTENBERG, D., Superconducting thin films, 18: 34157
GESTBLOM, Bo, Analysis of high-resolution NMR spectra, 18: 34309
GHATNEKAR, M. V., Primary effects of different mutagens in *Vicia faba*, 18: 33303
GHOSE, A. M., Coherent scattering cross sections of γ rays, 18: 35053
GIBBS, William D., Whole-body retention of I-131 in box turtles, 18: 33254
GIERASCH, P. J., Hypersonic magnetohydrodynamics with or without blunt body, 18: 34272 (NASA-CR-88)
GIFFON, Maurice, Analyticity of S matrix with regard to variable angular moment, 18: 34637 (NP-14076)
GIGNOUX, Dominique, Electrostatic generators in space power systems, 18: 33720
GILDENBURG, V. B., Nonlinear effects in inhomogeneous plasma, 18: 35024
GILEADI, A. E., Nuclear education and training at Israel Research Reactor, 18: 35219 (IA-894)
GILEADI, A. E., Reactor physics research at Israel Research Reactor, 18: 35218 (IA-892)
GILLARDEAU, J., Chlorine trifluoride, 18: 33522 (CEA-2360)
GILLET, C., Radioprotective effect of chlorides of Na, Ca, and Mg on barley, 18: 33409
GILLET, V., Particle-hole description of Pb-208, 18: 34889
GILLET, Vincent, Particle-hole description of C-12 and O-16, 18: 34824
GILLET, Vincent, Particle-hole description of odd-parity states of Ca-40, 18: 34831
GILLETTE, J. H., Prog. rpt. of Isotopes Division, 1–3/60, 18: 34006 (ORNL-TM-889)
GILLETTE, J. H., Prog. rpt. of Isotopes Division, 1–3/61, 18: 34007 (ORNL-TM-890)
GILLIESON, A. H., Impurity analysis in refractory methods, 18: 33515
GILMORE, F. R., Potential energy curves for N_2, NO, and O_2, 18: 34281 (RM-4034-PR)
GIRARD, P. F., Delayed radionecroses of central nervous system, 18: 33290
GJELLESTAD, Gore, Studies in geomagnetism, 18: 34673
GLASEL, Joy A., Chemical compounds on comets, 18: 34402
GLASHOW, S. L., Baryon resonances in W, symmetry, 18: 34553
GLASSER, M. L., Note on the evaluation of some Fermi integrals,

18: 34654
GLAZKOVA, I. P., Reaction diffusion in metal–complex gas systems. VII., 18: 34146
GLAZUNOV, Yu. Ya., Photoneutron spectra from Pt, Bi, Pb, and U, 18: 34945
GLENDENIN, L. E., Helium-ion-induced fission of Pb^{206} and Bi^{209}, 18: 34880
GLENN, E. E., Nuclear test detection spacecraft, 18: 33703
GLIGORIJEVIC, J., Radiation contamination of animal foods, 18: 33255
GLOECKLER, G., Evidence for >30-kev electrons accelerated in earth's magnetospheric boundary, 18: 34680
GLOKOVA, E. (Ye.) S., Introducing meteorological corrections into cosmic-ray intensity data, 18: 34466 (NASA-TT-F-126(p.194-214))
GLUSHKO, P. I., Reactions of $MoSi_2$ with Be, 18: 34149
GODBEE, H. W., Conversion of high-level radioactive waste solutions to glassy solids, 18: 35237 (ORNL-3629)
GODBEE, H. W., Fixation of high-level radioactive wastes in glassy solids, 18: 35236 (ORNL-3612)
GODFREY, B., Measurements of Ra in Ra luminizers, 18: 33262
GOEDEMOED, S. H., Magnetic and caloric effects in a hard superconductor, 18: 34712
GOGOSOV, V. V., Heat transfer in ionized nonisothermal plasma, 18: 35026
GOLDAN, P. D., Microwave interactions in cryogenic afterglow plasmas, 18: 35015
GOL'DANSKII, V. I., Mössbauer effect and its applications in chemistry, 18: 33604
GOLDBERG, A., Electromagnetic structure of the 3-nucleon system, 18: 34912
GOLDBERG, Edward D., Sedimentary profile across the North Atlantic, 18: 33790
GOLDBERG, H. S., Polarization of 40-Mev protons, 18: 34550
GOLDBERG, M., Decay modes and properties of the X^0, 18: 34592
GOLDBERG, R. A., Geomagnetic control of diffusion in the upper atmosphere, 18: 34678
GOLDFARB, D. M., Induction of h-mutations in extracellular phage T2 by γ irradiation, 18: 33297
GOLDFARB, L. J. B., Neutron tunneling process in Coulomb field, 18: 34894
GOL'DIN, M. L., Calculating radioactive source of density meter, 18: 33847 (AEC-tr-6399(p.124-37))
GOL'DIN, M. L., Measurement of humidity of friable bodies by neutron slowing-down method, 18: 33470 (AEC-tr-6399(p.83-91))
GOL'DIN, Mo. L., Gamma relays for drops in radiation intensity, 18: 33846 (AEC-tr-6399(p.30-42))
GOL'DIN, Mo. L., Hysteresis of thyratron relays, 18: 33845 (AEC-tr-6399 (p.21-9))
GOLDMAN, A. S., Self-diffusion studies of delta Pu, 18: 34191
GOLDMAN, Arthur G., Kinetics of K-42 distribution in human subjects, 18: 33238
GOLDMAN, K. L., Nuclear test detection spacecraft, 18: 33703
GOLDSTEIN, J. H., Signal enhancement of the Varian A-60 NMR spectrometer, 18: 33866
GOLDSTEIN, L., Microwave interactions in cryogenic afterglow plasmas, 18: 35015
GOLDWASSER, E., Biosynthesis of 5-ribosyluracil-5'-monophosphate in *Tetrahymena pyriformis*, 18: 33246
GOLDWASSER, E., Effect of erythropoietin upon heme synthesis by marrow cells, 18: 33242
GOMBOSI, Eva, Determination of frequency of various types of events, 18: 33892
GOMBOSI, Eva, Inelastic two-prong π^--p interactions, 18: 34520
Gonzalez, R. Diez
see Diez Gonzalez, R.
GOODMAN, Harrison D., Radiation protection at wall openings for duct or pipe, 18: 35049
GOPINATH, D. V., Coherence of failure for hypothetical meltdown accidents in EBR-II-like reactor, 18: 35059 (ANL-6844)
GOPINATHAN, K. P., Decay of Pt-197m, 18: 34879
GORDEN, R., Jr., Gamma radiolysis of propane, 18: 33642
GORDON, B. E., Modifications of scalers for rate studies, 18: 33868
GORDON, E., Nerva thermal and fluid flow analysis, 18: 33751
GORDON, Gilbert, Determination of H in D_2O, 18: 33539
GORDON, R., Fission distribution in seven-pin cluster fuel elements, 18: 35131
GORE, J. V., Plasma trapping within the magnetosphere, 18: 34984
GORICHEV, P. A., Angular correlation between fragments in multiple formation, 18: 34940
GORN, L. S., Selection of α emitter thickness for low-level radioactive probe spectrometry, 18: 33894
GOROKHOV, I. M., Age of Ni-bearing pluton with K–Ar and Rb–Sr methods, 18: 33781
GORSHKOV, V. G., Fermion Regge poles in processes involving vectons, 18: 34620
GORSHKOV, V. G., Relativistic atomic photoeffect, 18: 34847
GORTER, C. J., Magnetic and caloric effects in a hard superconductor, 18: 34712
GOSHEK, B., Energy balance and radiation sensitivity in rats, 18: 33365
GOSSARD, A. C., Bromine NMR in ferromagnetic $CrBr_3$, 18: 33584
GOTODA, Masao, Gamma-induced polymerization of ethylene, 18: 33649
GOUJON, Paul, Analysis of H_2O–D_2O mixtures, 18: 33460 (CEA-R-2440)
GOURDINE, M. C., Performance of electrogasdynamic generators, 18: 34501
GOYA, H., Determination of Ce-141 and Ce-144 in fission-product mixtures, 18: 33465 (USNRDL-TR-756)
GRABOVSKII, Ya., Angular distribution of products of multinucleon transfer reactions, 18: 34763 (JINR-P-1675)
GRAD, H., Method for confining plasma, 18: 35047
GRAD, Harold, Variational properties of hydromagnetic equilibria, 18: 34326
GRADSZTAJN, E., Monte Carlo intranuclear cascade calculations on C-12, 18: 34922
GRAEBNER, H.-J., Photometric determination of Ce in steels and alloys, 18: 33504
GRAEFF, G., Inner-outer exchange interactions of TlF molecule, 18: 34936
GRAF, Donald L., Oxygen isotope studies on origin of dolomites, 18: 33786
GRAHAM, R. A., Compressed gas gun for controlled planar impacts over wide velocity range, 18: 33756
GRAMENITSKII, I. M., Reaction $\pi^- + Xe \rightarrow \pi^- + \pi^0 + Xe$ for 9-Bev/c primary π^- mesons, 18: 34949
GRANT, Peter John, Thermal reactors, 18: 35109
GRAY, Peter, Calculation of molecular friction constant, 18: 34308
GREEN, A. M., Particle-hole description of Pb-208, 18: 34889
GREEN, Earl L., Prog. rpt. on population genetics of mice under irradiation, 7/63–6/64, 18: 33281 (TID-20844)
GREEN, H. S., Lambda-nucleon forces and hypernuclei structure, 18: 34857
GREEN, H. S., Structure and energy levels of light nuclei, 18: 34833
GREEN, I. M., Effective interactions in the nuclear shell model, 18: 34869
GREEN, Leon, Commercial power reactors cooled with Na, D_2O, or organic liquids, 18: 35161 (TID-8540(p.71-129))
GREEN, W. B., SNAP reactor handbook—transient analysis, 18: 35201 (NAA-SR-9368)
GREENBERG, Sherman, Behavior of cladding materials in H_2O and steam, 18: 34076 (TID-8540(p.213-330))
GREENE, E. F., Scattering of K by HCl and HI in crossed molecular beams, 18: 33560
GREENFIELD, M. A., Indium-115 thermal cross section ratios, 18: 34884
GREENFIELD, M. A., Nondestructive determination of U-235 content of SNAP fuel rods. II., 18: 34044 (NAA-SR-9600)
GREENLAND, R. V., Maximum component temperatures in gas-cooled Magnox reactor fuel channels, 18: 35182
GREINER, W., Collective g factor in deformed nuclei, 18: 34939
GREINER, Walter, Coriolis anti-pairing and blocking effects in deformed even-even nuclei, 18: 34775 (TID-20875)
GRENCH, H. A., Fast-neutron capture and inelastic-scattering cross sections of In-113 and In-115, 18: 34962
GRIBBLE, Robert F., Diagnostics of theta-pinch plasma, 18: 35013
GRIDIN, I. A., Automatic coordination of operation of machines for delivery of coke, 18: 33987 (AEC-tr-6399(p.202-6))
GRIFFIN, C. W., Application of power spectra to reactor-system analysis, 18: 35071 (TID-7679(p.107-33))
GRIFFIN, John J., Sedimentary profile across the North Atlantic, 18: 33790
GRIFFITH, O. Hayes, ESR and molecular motion of radicals in x-irradiated ester–urea inclusion compounds, 18: 33641
GRIFFITH, T. C., Polarization analyzer for protons, 18: 33949
GRIGOR'EV, Yu. G., Biological effects and RBE of high-energy protons, 18: 33286 (UCRL-Trans-1068)
GRILLMAIER, R., Thoron in breath of Thorotrast patients, 18: 33425
GRILLMAIER, R., Thorotrast deposits in the kidney, 18: 33426
GRIMLEY, T. B., Energy of an N-electron system, 18: 34353
GRIMSHAW, J. A., Displacement energy in GaAs, 18: 34352
GRINENKO, L. N., Isotopic S composition of ore sulfides, 18: 33767
GRITCHENKO, Z. G., Contamination of vegetation by Sr-90 and Cs-137, 18: 33235 (AEC-tr-6448)
GROBMAN, Jack, Heavy-molecule propellants in electron-bombardment thrustor, 18: 33696 (NASA-TN-D-2401)
GROMOV, K. Ya., Alpha spectra of Tb isotopes, 18: 34766 (JINR-P-1687)
GROMOV, V. A., Change in composition of liver lipid of irradiated animals, 18: 33360
GROMTSEV, Yu. V., Preparation of pure U salts, 18: 33599
GROSS, R. A., MGD boundary conditions at a conducting wall, 18: 35005

GROSSMAN, Jacob, Kinetics of K-42 distribution in human subjects, 18: 33238
GROSSMANN, Alexander, Nested Hilbert spaces in quantum mechanics. I., 18: 34651
GROSSMANN, V., Effect of physostigmine on irradiated rats, 18: 33306
GROTE, H. H., Observations of 1962 Johnston Island nuclear tests, 18: 34676
GROTOWSKI, K., Elastic scattering of 24.7-Mev α particles, 18: 34902
GROVE, G. R., Prog. rpt., 4/64, 18: 35246 (MLM-1196)
GRUBER, B., Uniqueness of the harmonic oscillator commutation relation, 18: 34662
GRUBER, J. B., Spectrum of Er^{3+} in single crystals of Y_2O_3, 18: 34305
GRUBER, John B., Energy levels of Er^{3+} in LaF_3, 18: 33562
GRUNBERGER, Ch., Data processing at EDF-3 Chinon Plant, 18: 34017
GRUZDEV, A. D., Effect of irradiation of chromosomes of dividing cell on formation of cell membrane, 18: 33372
GUBBIOTTI, A., Hemolysis by ionizing radiation, 18: 33345
GUDA, V. A., Radiation safety in flights of Soviet cosmonauts, 18: 33815
GUENTHER, E., Szilard-Chalmers effect in solid XeF_4, 18: 33666
GUERRA, C. R., Hydrogen–deuterium kinetic-isotope effect, 18: 33573
GUERSEY, F., Spin and unitary spin independence of strong interactions, 18: 34582
GUESSOUS, Abdelmalek, Counting of particles from target bombardment with variable beam, 18: 33899
GUILLOTEAU, Rene, Pneumatically controlled gripping tongs, 18: 33726
GULLIVER, Peter Leslie, Storage means for radioactive fuel elements, 18: 33725
GUMAN, William J., Surface effects in pulsed plasma accelerator, 18: 34980
GUMENYUK, V. S., Thermal expansion of W, Mo, Ta, Nb, and Zr at high temperatures, 18: 34190
GUNBY, A. L., Reactivity absorbed by Na in SRE, 18: 35149 (NAA-SR-9509)
GUNDZIK, M., Decay modes and properties of the X^0, 18: 34592
GUPTON, E. D., Energy response of the ORNL Cutie Pie Chamber to photon radiation, 18: 33883 (ORNL-TM-897)
GUSHCHIN, Yu. V., Control device for using modulated radioactive radiation, 18: 33843 (AEC-tr-6399(p.1-9))
GUSHCHIN, Yu. V., Dosing system for automatic control device, 18: 33851 (AEC-tr-6399(p.177-85))
GUSS, D. E., Modulation of low-energy galactic cosmic-ray H and He, 18: 34482
GUTNIAK, Guni, Radiation effects on biosynthesis of heme, 18: 33400
GVOZDEV, B. A., Ratio of cross sections for formation of isomer pair Sc-44, 44m, 18: 34948
GWIN, R., Ratio of capture-to-fission in U-235, 18: 34886
GYOERGYI, G., Symmetry properties of Nogami's modified pairing hamiltonian, 18: 34890

H

HAAS, Francis X., Low-temperature dynamic nuclear polarization, 18: 34717
HABANEC, J., Polarization measurements with protons scattered on C, 18: 34809
HABERMANN, C. E., High-temperature resistivities of Dy, Ho, and Er, 18: 34162
HACKAM, R., Positive ion mobilities and conversion rates in He afterglow, 18: 34351
HADEK, V., Total dose intensity of fission products, 18: 33633
HAEFNER, Klaus, Ploidy degree dependence of radioinduced mutation rates, 18: 33394
HAEN, Pierre, Thermal conductivity and thermoelectric force of U–Mo, 18: 34143
HAEUSSLER, Peter, Multiple emissions of secondary electrons, 18: 34450
HAGGERTY, M. J., Kinetic equation for homogeneous plasma in uniform magnetic field, 18: 35037
HAGI, Mikiko, Measurement of plasma conductivity. I., 18: 35000
HAGI, Mikiko, Measurement of plasma conductivity. II., 18: 35001
HAGIOYA, Kinichi, The void and hole effect in D_2O-moderated reactor, 18: 35083
HAGIWARA, Miyuki, Gamma-induced polymerization of ethylene, 18: 33649
HAGSGORD, S., Prog. rpt. on personnel dosimetry, annual, 1963, 18: 33798 (AE-147)
HAGSTROEM, S., Double-focusing β spectrometer (50 cm), 18: 33947
HAGSTROEM, Stig, Extension of the photoelectron method to elements of low atomic number, 18: 34414
HAHN, R. B., Analytical uses of bromanilic acid, 18: 33498
HAIJ, Marion E., Cancer mortality among underground metal miners, 18: 33813
HAINES, Geoffrey Herbert, Thermal reactors, 18: 35109
HAINS, F. D., Stability of MHD channel flow, 18: 34267 (D1-82-0331)
HAITZ, R., Radiation damage in Si avalanche diodes, 18: 34248
HAKE, R. R., Superconductivity in some alloys of Ti with Mn and Co, 18: 34700
HALEVY, E., Precipitation of Sr by $CaCO_3$ in calcareous soils, 18: 33594
HALL, P. M., Superconducting thin films, 18: 34157
HALSEY, Herbert, Apparatus for detecting radioactive particle emission, 18: 33976
HAMA, Yogiro, p-p Scattering at 660 Mev, 18: 34601
HAMA, Yogiro, p-p Scattering at 970 Mev, 18: 34602
HAMILL, W. H., Secondary ions produced by ion-neutral reactions, 18: 33569
HAMILTON, Howard B., Adolescents exposed *in utero* to atomic bomb. I., 18: 33391
HAMILTON, John R., Radiation effects on living trees, 18: 33282 (TID-20876)
HAMMAN, D. J., Effect of space environment on materials, 18: 34235
HAMMOND, C. W., Heat exchanger, 18: 33754
HANAUER, S. H., Negative reactivity measurement by neutron fluctuation analysis, 18: 35074 (TID-7679(p.171-81))
HANEVIK, A., Steel irradiation program, 18: 34219 (RCN-26)
HANNABACH, J., Radiation tolerance of TIMM, 18: 33869
HANSEN, D., Survey of 60° beam at Princeton-Pennsylvania accelerator, 18: 34380
HANSEN, E. C., Isotopic Hf resonance-absorption data, 18: 34883
HANSEN, H., K ionization through electron and positron ions, 18: 34431
HANSEN, K. F., Startup of solid core nuclear rockets, 18: 35213
HANSEN, N. E., Angular distribution of bremsstrahlung intensity for 10- and 20-Mev electrons, 18: 34459
HANSEN, O., Reactions (p,α) to N = 28 nuclei, 18: 34855
HANSEN, P. G., Decay of 23.5-min U-239, 18: 34850
HANSEN, P. G., K-forbidden β decay of Tb-160, 18: 34844
HANSTEEN, J. M., Refined cluster wave functions for Li-6, 18: 34631
HANTABAL, Eugen, Metabolism of Ce-144, 18: 33252
HARA, Yasuo, Reciprocal bootstrap relationship of the octet baryon and the decuplet baryon, 18: 34575
HARARI, H., Unitary symmetry in meson-baryon reaction, 18: 34585
HARBOTTLE, G., Sodium azide crystals containing N-13 recoil atoms, 18: 33663
HARDEMAN, G. E. G., Suppression of nuclear dynamic polarization, 18: 34334
HARDIE, D., Hydrogen embrittlement of some Zr alloys, 18: 34169
HARDISON, Harold V., Walk-through hand and shoe monitor for β-γ contamination, 18: 33877 (DP-893)
HARDY, J. C., Decay of Ne-17 and delayed proton emission, 18: 34899
HARLOW, Francis H., Heat transfer in von Karman wake of rectangular cylinder, 18: 33748
HARPER, P. V., Nuclear needle for use in neurosurgery, 18: 33436
HARRIS, A. K., Observations of 1962 Johnston Island nuclear tests, 18: 34676
HARRIS, A. M., Drive mechanism, 18: 35110
HARRIS, I. R., Constitution of Y–Ce and Y–La alloys, 18: 34160
HARRIS, I. R., Lattice spacings of Th–Ce alloys, 18: 34161
HARRIS, S. M., Two-quasiparticle $K\pi = 0^-$ states in deformed even-even nuclei, 18: 34907
HARRISON, A. G., Electron impact study of methyl phenyl ethers, 18: 33627
HARRISON, C. W., Jr., Receiving characteristics of two-wire lines excited by uniform and non-uniform electric fields, 18: 35249 (SC-R-64-164)
HARRISON, S., Junction counters produced by ion implantation doping, 18: 33921
HART, E. L., Decay modes and properties of the X^0, 18: 34592
HART, H. R., Jr., Prog. rpt. on superconducting properties of materials, 12/15/63–6/15/64, 18: 34683 (NP-14136)
HARTMAN, C. J., Chemistry of BWR, 18: 35186
HASELKORN, R., Enzymatic synthesis of RNA. III., 18: 33245
HASHIMOTO, Isao, Retardation factors for ion exchange columns, 18: 33684
HASIBOV, I. O., Reactions of Ce and Ga selenides, 18: 33552
HASSID, A., Liquid volume fraction in two-phase adiabatic flow, 18: 33732 (EURAEC-1086)
HASTED, J. B., Near-resonance charge transfer process, 18: 34448
HATCH, L. P., Downflow packed-bed nuclear fission reactor, 18: 35124
HATCHER, C. R., Angular distribution of bremsstrahlung intensity for 10- and 20-Mev electrons, 18: 34459
HATHERLY, M., Exchange parameters in Fe–Ni alloys, 18: 34187
HATSCHEK, Rudolf, Apparatus for irradiation or vacuum-coating of specimens, 18: 33763
HAUBENREICH, P. N., Reactor safety analysis, MSRE design, 18: 35152 (ORNL-TM-732)
HAUGER, J. R., X-ray spectrographic analysis for trace quantities of Ta in Nb, 18: 33458 (BM-RI-6483)

HAUSER, O., Changes of crystal structure by neutron irradiation, 18: 34241
HAUTH, Joseph J., Process for fabrication of fuel elements, 18: 34118
HAWKINS, D. B., Removal of Co and Cr from citrate-containing radioactive liquid waste, 18: 35235 (IDO-12036)
HAY, H. J., Search for low-lying ½⁺ level in B-9, 18: 34892
HAYDEN, H. W., Activated sintering of W, 18: 34098
HAYDEN, Owen, Reactors cooled by liquid metal, 18: 35122
HAYDON, M. P., Characterization of spheroidal UO_2 particles and fabrication variables for fuel plates, 18: 34088 (ORNL-3645)
HAYES, P. A., Corrosion treatment for cooling water circuits, 18: 35063 (IG-Report-52)
HAYES, W., Infrared absorption of H^- and D^- ions in CaF_2, 18: 34262 (AFCRL-64-284)
HEALY, Mark, Prog. rpt. on vapor volume fraction and slip velocity, 4–6/64, 18: 33729 (ACNP-64027)
HEARN, A. G., Radiative transfer of Doppler broadened resonance lines. II., 18: 35019
HEATH, R. L., Scintillation spectrometry γ-ray spectrum catalog, 18: 34755 (IDO-16880-1)
HEATH, R. L., Scintillation spectrometry γ-ray spectrum catalog, 18: 34756 (IDO-16880-2)
HEENEY, H. B., Effects of γ radiation on fresh strawberries, 18: 33993
HEESTAND, R. L., Fabrication of U_3O_8–Al composite fuel plates, 18: 34087 (ORNL-3644)
HEHL, K., X-γ correlation by stripping reactions, 18: 34873
HEINRIKSON, R. L., Biosynthesis of 5-ribosyluracil-5'-monophosphate in *Tetrahymena pyriformis*, 18: 33246
HEINS, Harold, Thermoluminescent dosimeter, 18: 33981
HEISKALA, Victor H., Irreversible vapor condensation, 18: 34323
HEISS, W. D., Angular distributions of fast photoneutrons, 18: 34935
HELFER, H. L., Abundances in K giant stars. I., 18: 34385
HELLENS, Robert L., Reactor-physics for water-moderated lattices of slightly enriched U, 18: 35113 (TID-8540(p.529-609))
HELVY, F. A., Prog. rpt. on 5-inch high-speed photomultiplier, final, 6/63–6/64, 18: 33882 (NYO-3190-1)
HENDERSON, Courtland M., Generation of power using emissive materials, 18: 34505
HENDERSON, D. B., Hypersonic magnetohydrodynamics with or without blunt body, 18: 34272 (NASA-CR-88)
HENDERSON, Richard W., Determining release from point source, 18: 33803 (LA-3094)
HENDRICKS, J. W., High-temperature high-vacuum thermocouple drift tests, 18: 33833 (ORNL-TM-883)
Hendricus van Oers, Willem Theodorus
see van Oers, Willem Theodorus Hendricus
HENINS, Albert, Standard reference wave lengths for x-ray spectroscopy, 18: 34341
HENINS, Ivars, Absolute scale of x-ray wave lengths, 18: 34340
HENLEY, Darwin R., Design and construction of new coaxial electrical discharge pin, 18: 33862
HENLEY, E. M., Finite superconductors and their infinite volume limit, 18: 34703
HENRY, Claude, Trajectories of sub-micronic particles in ionized fields, 18: 34314
HENRY, H. F., Neutron detector unit utilizing In, 18: 33978
HENRY, J. A., Problems in radiobiology from use of radioisotopes, 18: 33328
HENRY, J.-A., Radiobiological problems in utilization of radioisotopes, 18: 33420
HENRY, John Jewett, Thermal contact resistance, 18: 33735 (MIT-2079-2)
HENSCHKE, Ulrich K., Remote afterloading with intracavitary applicators, 18: 33446
HENSON, Bob L., Mobility of positive ions in liquefied Ar and N, 18: 34343
HERB, R. G., Detailed forms of yield curves from semi-thick Al targets, 18: 34917
HERBISON-EVANS, D., Quadrupole relaxation in N nuclear resonances, 18: 33615
HERMANN, Horst, Manipulator arm particularly for reactors, 18: 33723
HERMANN, Horst, Manipulator apparatus, 18: 33724
HERMIER, J., Effect of γ irradiation of *Bacillus subtilis* spores, 18: 33292
HERR, W., Nuclear reaction $^{191}Ir(n,\gamma)^{192}Ir$ in $Na_2IrCl_6 \cdot 6H_2O$, 18: 33662
HERRING, D. F., Cross sections for $O^{16}(d,p_0)O^{17}$, $O^{16}(d,p_1)O^{17*}$ and $O^{16}(d,\alpha_0)N^{14}$, 18: 34860
HERRMANN, Guenter, Determination of trace Pa-231, 18: 33495
HESTER, J. Charles, Properties of high-temperature He, 18: 34289
HEUSINKVELD, M., Method of continuous shock front position measurement, 18: 34357
HEVESY, G., Isotopic measurements on life-cycle of tissue cells, 18: 33226
HEYMAN, Henry, Reversible electromagnetic fluid pump, 18: 33727
HILARIS, Basil S., Remote afterloading with intracavitary applicators, 18: 33446
HILBORN, H. S., Prog. rpt. on HWR, 6/64, 18: 35061 (DPST-64-83-6)
HILL, B. J., Ground state of a many-fermion system. II., 18: 34559
HILL, C. R., Assessment of α radioactivity in human tissues, 18: 33819
HILL, F. L., VIf phase anomalies associated with nuclear explosions, 18: 34250 (AWRE-O-35/64)
HILL, Jack H., Transient motion of space charge through neutral gas, 18: 34364
HILL, R. A., Rapid scan spectrograph for plasma spectroscopy, 18: 34983
HILL, R. D., "Barrier-reef" model of resonance particles, 18: 34564
HILL, Roger Eugene, Pion-nucleon scattering at 310 Mev, 18: 34512 (UCRL-11140)
HIMES, R. C., Electrical properties of rare earth compounds and alloys, 18: 34158
HINCHEY, F. A., Milne problem in finite domain. I., 18: 34746
HINDER, G. W., Image intensifier system for observation of nuclear events, 18: 33909
HINDS, W. Ted, Ground-level air exposures resulting from emissions from stacks at Hanford, 18: 33801 (HW-80204)
HINRICHSEN, P. F., Stabilized scintillation counter, 18: 33934
HIRAKAWA, K., Exchange parameters in Fe–Ni alloys, 18: 34187
HIRAKAWA, Naohiro, Pulsed neutron experiment, 18: 34738
HIRAOKA, Toru, Pulsed neutron experiment, 18: 34738
HIRATA, Haruyoshi, Positron emission in decay of Eu-152, 18: 34820
HIROSHIGE, Noboru, Effects of f_0-meson on πN scattering, 18: 34611
HIROSHIGE, Noboru, f^0-Meson and p-p scattering, 18: 34610
HIROTA, Isao, Plasma confinement device with reversed field. I., 18: 34993
HIRSH, E. H., Sputter-ion pumps, 18: 33760
HIRSHFELD, A. T., Anomaly in response of semiconductor detectors, 18: 33916
HISHIDA, Hisashi, Experiments using Osaka University HITS. I., 18: 35225
HIZA, Elizabeth, Resin uptake of I^{131}-triiodothyronine as test of thyroid function, 18: 33437
HLADYSHEVSKYI (GLADISHEVSKII), E. Y. (I.), Crystal structure of Nb–Co β phase, 18: 34145
HO, I. T., Computer model of beam-generated plasma, 18: 35044
HOA, Duong N., ρ Exchange mechanism in reaction $\pi^+ + p \rightarrow N_{33}^{++} + \pi^0$, 18: 34626
HOA, Duong N., T = 2 pion-pion interaction, 18: 34630
HOBSON, D. O., Fabrication of U_3O_8–Al composite fuel plates, 18: 34087 (ORNL-3644)
HOCKENBURY, R. W., Fission cross section of Pu-241, 18: 34914
HODGE, Webster, Beryllium as a structural material, 18: 34141
HODGSON, T. S., Modifications of scalers for rate studies, 18: 33868
HOELZL, K., Inelastic electron-deuteron cross section, 18: 34555
HOFER, Lawrence J. E., Treating exhaust gases with urania-containing catalysts, 18: 33610
HOFFMAN, Rognar A., Analysis of high-resolution NMR spectra, 18: 34309
HOGG, G. R., Reaction $Si^{28}(\gamma,p)Al^{27}$, 18: 34901
HOLDEN, F. C., Dimensional instability in metals, 18: 34121 (DMIC-Memo-189)
HOLDEN, F. C., Refractory ceramics of interest in aerospace structural applications, 18: 34129 (RTD-TDR-63-4102(Suppl.1))
HOLLAND, R. E., Lifetimes of $d_{3/2}$ hole states in Sc isotopes, 18: 34923
HOLLANDS, George, Radiation protection at wall openings for duct or pipe, 18: 35049
HOLLINGSWORTH, D. R., Tuberculosis in Hiroshima, 18: 33225
HOLM, S., Reactions (p,α) to N = 28 nuclei, 18: 34855
HOLMBERG, P., Investigation of reaction $K^{39}(p,\gamma)Ca^{40}$ at 1103, 1131, and 1153 kev, 18: 34784
HOLMES, A., Use of γ spectrometry in bio-assay, 18: 33264
HOLOWAYCHUK, N., Strontium exchange of soils from Alaska, 18: 33777
HOLTZ, R. E., Application of electron-bombardment heating for boiling liquid metals, 18: 33731 (ANL-6869)
HOLZER, F., Method of continuous shock front position measurement, 18: 34357
HONECK, Henry C., Transport-theory calculations of temperature coefficients in heterogeneous reactor lattices, 18: 35118
HOOD, R. R., Prog. rpt. on D_2O-moderated power reactors, 5–6/64, 18: 35143 (DP-915)
HOOPER, J. W., Prog. rpt. on ionization of alkali ions by electron impact, 3–5/64, 18: 34406 (TID-20877)
HOPKINS, J. C., Inelastic scattering of 2- to 5-Mev neutrons by Fe, 18: 34740
HOPPES, D. D., Anomaly in response of semiconductor detectors, 18: 33916
HORACKOVA, O., Effect of physostigmine on irradiated rats, 18: 33306

HORN, G. R., Multicomponent tubular UO_2 fuel element irradiations, 18: 35129 (HW-80291)
HORNSBY, J., Coulomb scattering in focusing media—FORTRAN programs, 18: 34368 (CERN-64-29)
HORROCKS, D. L., Energy required to produce one photoelectron, 18: 33860
HORTON, R. W., Processing graphite reactor fuels, 18: 33687
HOSHIZAKI, Norio, p-p Scattering at 660 Mev, 18: 34601
HOSHIZAKI, Norio, p-p Scattering at 970 Mev, 18: 34602
HOSICK, Thomas A., Incorporation of unbound iodide-131 into non-radioactive hippuran molecule, 18: 33646
HOSLER, Charles R., Determining Rn concentration in air near ground, 18: 34257
HOSTE, J., Applications of radioisotopes in analytical chemistry, 18: 33483
HOUCK, J. R., New type of flux meter, 18: 33865
HOUELLE, Michel, Criticality experiments with annular cylinders containing Pu solutions, 18: 34494 (CEA-R-2495)
HOUSE, Lewis L., Neon VII and VIII wave lengths in vacuum ultraviolet, 18: 34384
HOUTERMANS, F. G., Lead of volcanic origin, 18: 33791
HOVI, Veeinoe, Beta energies of Pr-143, S-35, and Pm-147, 18: 34785
HOWARD, C. L., Prog. rpt. on Garigliano reactor, 7/64, 18: 35147 (GEAP-4645)
HOWARD, D. F., Investigation of the $PbMoO_4$–$Bi_2(MoO_4)_3$ phase diagram, 18: 34195
HOYLE, F., Abundances of U and Th in solar system, 18: 34401
HOYLE, F., Cosmic rays as an extragalactic phenomenon, 18: 34486
HOYT, G. L., Electron bombardment and contact ion engines, 18: 33698
HRUBEC, Zdenek, Adolescents exposed *in utero* to atomic bomb. I., 18: 33391
HRUSKA, A., Propagation of radio waves across plasma, 18: 34991
HRYNKIEWICZ, A. Z., Hfs interaction of Gd-155 nucleus, 18: 34898
HSU, Chen-mon, Formation of wheat mutants under influence of fast neutrons, 18: 33374
HSU, Yu-shen, Preparation of Mo single crystals, 18: 34061 (FTD-TT-64-350)
HUBACH, R. A., Ion engine ground testing techniques, 18: 34261 (AEDC-TDR-64-127)
HUBER, H., Cesium plasma capillary emitter as source of Cs ions, 18: 34502
HUBER, P., Report of the Federal Commission for control of radioactivity, 18: 33772
HUDSON, R. D., Atomic absorption cross section of Na vapor, 18: 34443
HUET, Andre, Apparatus for controlling reactor activity, 18: 35108
HUGGETT, R. W., Properties of very high-energy inelastic processes from measurements on recoil baryon, 18: 34632
HUGGINS, D. K., Infrared spectra of (CO), $Mn_2(CO)_{10}$, 18: 33551
HUGHES, V. W., Fine-structure constant from muonium hfs interval, 18: 34921
HUIZENGA, J. R., Helium-ion-induced fission of Pb^{206} and Bi^{209}, 18: 34880
HULL, D., Substructure in refractory metals, 18: 34204
HULL, D. E., Precise measurement of flow rates with radioisotopes, 18: 33750
HULSIZER, P. I., Scanning and measuring projector, 18: 33957
HUMPHREY, W. E., Scanning and measuring projector, 18: 33957
HUNT, T. K., Fluxoid conservation by superconducting thin film rings, 18: 34698
HURST, Edmond C., Titanium primer for evapor-ion pump, 18: 35258
HURST, Lucienne, Changes produced in rat liver by irradiation. I., 18: 33380
HURST, R. P., Magnetic susceptibility of 2 $^1S_1$ state of He, 18: 34438
HUSSAIN, Syed R., Research Reactor at Islamabad, 18: 35229
HUTCHEON, John Malcolm, Nuclear reactor, 18: 35123
HUTH, Gerald C., Internal pulse amplification in Si p-n junction, 18: 33959
HYODO, Tomonori, Backscattering of γ rays from Fe slabs, 18: 35054

I

IACHELLO, F., Disintegration intensity and angular momenta in radioactive decay, 18: 34800
IANNI, P. W., Tests on EVESR MK I fuel bundle, 18: 35144 (GEAP-4560)
IANNIELLO, L., Brittleness of α Pu, 18: 34198
IBRAGIMOV, Sh. I., Radiation effects on cotton seeds, 18: 33333
ICHIMURA, Hiroshi, Note on cluster expansion for quantum gases, 18: 34664
ICHIMURA, Munetake, Generalization of Bremond-Valatin method for 4-body correlation, 18: 34600
IGUCHI, Masayuki, Plasma confinement device with reversed field. I., 18: 34993
IIJIMA, Tsutomu, Pulsed neutron experiment, 18: 34738
IIZUKA, Jugoro, Nonleptonic hyperon decays, 18: 34609
IJAZ, Mujaddid A., Proton-proton inelastic scattering at 2 Bev, 18: 34633
IKENBERRY, Dennis, Rotational magnetic moment of the H molecule, 18: 34436
IKUSHIMA, Akira, Acoustic attenuation studies of frictional force on fast moving dislocation, 18: 34276 (NP-14129)
IL'ICHEVA, Z. F., Effect of radiation on polypropylene, 18: 34243
IL'IN, L. A., Effectiveness of DTPA in contamination of lethal doses of Ce-144, 18: 33417
IMAIZUMI, Minoru, Fast neutron time-of-flight system, 18: 33944
IMGRAM, A. G., Transition properties of wrought Ta and Nb, 18: 34196
IMOTO, Shosuke, Formation of UC_{1-x} N_x, 18: 33576
IMRIE, D. C., Polarization analyzer for protons, 18: 33949
INFELD, E., Exact solutions of MHD equations for magnetic plane-symmetrical fields, 18: 34295
INGALLS, E. L., Prog. rpt. on converter for nuclear thermionic energy source, final, 5/3–12/3/63, 18: 34497 (NP-12888(Vol.5))
INGRAM, G. E., Compressed gas gun for controlled planar impacts over wide velocity range, 18: 33756
INGRAM, M., Early detection of altered blood-cell production, 18: 35256
INGRAM, M., Radiation sensitivity of bacterial spores, 18: 33996
INGRAM, M., Radiation sensitivity of vegetative bacteria, 18: 33326
INO, Taketoshi, Effects of ξ-meson on πN scattering, 18: 34611
INO, Taketoshi, ρ-Meson and p-p scattering, 18: 34610
INOUE, Kazuhiko, Deviation from 1/E distribution in epi-cadmium neutron spectrum, 18: 34735
INOZEMTSEVA, O. I., Azimuthal telescope for investigation of variations of cosmic rays, 18: 33888 (NASA-TT-F-126(p.138-60))
INSLEY, H., Phase equilibria in $NaF–BeF_2–ThF_4$ system, 18: 33582
INSTON, Rita R., Metabolism of lipidic peroxides. II., 18: 33236 (ANL-Trans-54)
INUISHI, Yoshio, Radiation damage of carrier life time in Si, 18: 34228
IREDALE, P., Image intensifier system for observation of nuclei events, 18: 33909
IRIARTE, J., Uv irradiation of 11-oxo-steroids. IV., 18: 33634
IRVINE, J. M., Pairing correlations in finite systems. II., 18: 34927
ISAEV, P. S., Relativistic corrections to s and p waves of π-N scattering, 18: 34507 (JINR-E-1686)
ISENOR, N. R., High-energy ions from Q-switched laser, 18: 34297
ISHIMORI, Tomitaro, Solvent extraction in TBP–HNO_3 or -HCl systems, 18: 33685
ISHIMOTO, Makoto, Photoreactivation of uv-inactivated polyuridylic acid, 18: 33392
ISHIZAKI, Yoshihide, Numerical differential cross sections of $Ca^{44}(p,d)Ca^{43}$ at 55 Mev, 18: 34757 (INSJ-72)
ISKENDERIAN, Haig P., Breeder reactor core, 18: 35192
ISMAIL, A. H., Lean body mass from K-40 measurements, 18: 33487
IVANOV, K. V., Change in cardio-vascular system in rabbits chronically irradiated, 18: 33364
IVANOV, V. E., Deformation and fracture of rolled Be, 18: 34140
IVANOV, V. I., Central M-choline reactive systems of irradiated mice, 18: 33368
IVANOVSKAYA, I. A., Reaction $\pi^- + Xe \rightarrow \pi^- + \pi^0 + Xe$ for 9-Bev/c primary π^- mesons, 18: 34949
IVANOVSKII, M. A., Particle losses and configuration of plasma jet moving along curved magnetic field, 18: 35023
IVANOVSKII, N. N., Thermodynamic calculations of reaction of Na and H_2O, 18: 33528 (NP-14080)
IWAMOTO, Fumiaki, Linearized many-body problem, 18: 34342
IWAO, S., Three-body NNΛ force, 18: 34878
IZU, Masatsugu, Radiation-induced polymerization of 3,3-bis-chloromethylcycloxabutane, 18: 33651

J

JACAVANCO, Daniel J., Antenna pattern distortion due to plasma layer, 18: 34968 (AFCRL-64-18)
JACCARINO, V., Bromine NMR in ferromagnetic $CrBr_3$, 18: 33584
JACKSON, Julius L., Trapped trajectories in Brownian motion, 18: 34311
JACKSON, P. M., NPR steam generator tubing burst tests, 18: 35195 (HW-82233)
JACKSON, S., Determination of radionuclides in urine, 18: 33518
JACKSON, S., Estimation of U from urine analysis, 18: 33268
JACOBS, James M., Bibliography on heavy water production, 18: 34008 (TID-3091(Suppl.1))
JACOBS, K. C., Fermi-liquid effects in cyclotron resonance, 18: 35045
JACOBS, K. G., Measuring apparatus for electron densities in plasma, 18: 34969 (AFCRL-64-247)
JACOBS, Leon, Radiation effects on *Toxoplasma gondii*, 18: 33331
JACOBSEN, Edwin, Jr., Improvements in or relating to shelters, 18: 33758
JACOBSON, Leon O., Prog. rpt. on biological research, semiannual, 3/64, 18: 33211 (ACRH-21)
JACOBSON, Max, Derivation of fugacity coefficients from improved equation

of state, 18: 33531 (UCRL-11369)
JAFAR, J. D., Production of He-3 from deuteron interactions, 18: 34544
JAKESOVA, L., Compaction of UO_3 powder, 18: 34094
JAKLEVIC, R. C., Quantum interference effects in superconductors, 18: 34696
JAMES, Edward, Unsolved problems of explosive sensitivity, 18: 35252 (UCRL-7898)
JAMIESON, John C., X-ray diffraction studies on Dy at high pressures, 18: 33591
JANA, Manas K., X-ray induced mutants of *Phaseolus mungo* L. II., 18: 33324
JANKIEWICZ, C., Baryon-charge and hyper-charge, 18: 34647
JANOSSY, L., Determination of frequency of various types of events, 18: 33892
JANOSSY, L., Hydrodynamical model of wave mechanics. II., 18: 34638
JANOVSKY, I., Radiation effects on ketone extraction. II., 18: 33621 (UJV-977/64)
JANSEN, Laurens, Stability of crystals of rare-gas atoms and alkali halides. I., 18: 34706
JANUSKA, Karel, Calculation of fuel cycles of gas-cooled power stations, 18: 35179
JAYARAMAN, A., Fusion curve of Eu, 18: 34184
JAYARAMAN, H., Limitations on isotopes in reaction mechanisms. II., 18: 33985
JEFFRIES, R. A., Shock reflection in high-explosive shock tube, 18: 34332
JEGER, O., Photochemical rearrangement of steroids, 18: 33635
JEGER, O., Uv irradiation of 11-oxo-steroids. IV., 18: 33634
JEHANNO, C., Secondary emission statistics, 18: 33911
JEKES, D., Preparation of active UO_3, 18: 33533 (UJV-725/63)
JENKINS, T. L., Large liquid scintillator for detection of antineutrino reactions, 18: 33901
JENSEN, C. A., Intense 584-Å light from simple continuous He plasma, 18: 35012
JENSEN, T. H., Electron drift velocities in noble and "moderator" gases, 18: 34322
JIBUTI, R. I., Absorption of π^- mesons and correlation of nucleons in light nuclei, 18: 34851
JIRU, P., Exchange reactions of O-18 with oxidation catalysts. II., 18: 33545
JOCKEY, Pierre, Physical basis of radiotherapy and radiobiology, 18: 33228
Johannes de Boer, Thijs
see de Boer, Thijs Johannes
JOHANSEN, Else R., Preparing α- and β-spectroscopy sources, 18: 33654
JOHANSON, B., Regeneration of bone marrow, 18: 33216
JOHANSSON, Lars, Inorganic ion exchangers. I., 18: 33535
JOHNSON, D., High-speed decade pulse counting, 18: 33956
JOHNSON, Irving, Role of coprecipitation in alloy partition during crystallization, 18: 34192
JOHNSON, N. R., K-forbidden β decay of Tb-160, 18: 34844
JOHNSON, Paul G., Summary of nuclear rocket applications, 18: 35214
JOHNSON, W. C., Prog. rpt. on lattice and electronic defects in solids, final, 6/64, 18: 34280 (NYO-2680-1)
JOHNSON, W. R., Single-quantum annihilation of positrons, 18: 34577
JOHNSTON, H. S., Hydrogen–deuterium kinetic-isotope effect, 18: 33573
JOHNSTON, Zelma Jean, Crystal structures of some new superconducting compounds, 18: 34283 (UCRL-11390)
JOHNSTONE, I. P., Pairing correlations in finite systems. II., 18: 34927
JOMBIK, J., Radiometric determination of ash in vegetable drugs, 18: 33480
JONES, A. R., Effects of steam pressure on reactor economics, 18: 35184
JONES, B. Frank, Jr., Determination of diffusivity of isotropic medium, 18: 34018
JONES, E. D., Bromine NMR in ferromagnetic $CrBr_3$, 18: 33584
JONES, G. D., Infrared absorption of H^- and D^- ions in CaF_2, 18: 34262 (AFCRL-64-284)
JONES, K. W., Cross sections for $O^{16}(d,p_0)O^{17}$, $O^{16}(d,p_1)O^{17*}$ and $O^{16}(d,\alpha_0)N^{14}$, 18: 34860
JONES, L. V., Prog. rpt., 4/64, 18: 35246 (MLM-1196)
JONES, W. Barclay, Isomerism in At-212, 18: 34777 (UCRL-11238)
JORTNER, D., Direct cycle radioisotope-heated rocket engine, 18: 34003
JOSEPH, P. T., Analytical uses of bromanilic acid, 18: 33498
JOSHI, M. C., Decay of Pt-197m, 18: 34879
JOUBERT, Jack, Trajectories of sub-micronic particles in ionized fields, 18: 34314
JOVANCEVIC, F., Radiation contamination of animal foods, 18: 33255
JOVANOVICH, J. V., Magnitude of the K_1^0–K_2^0 mass difference, 18: 34593
JUDD, B. R., Missing band in spectrum of Am^{3+}, 18: 33574
JULLIOT, C., Secondary emission statistics, 18: 33911
JUNA, J., Interaction of deuterons and Li and occurrence of γ radiation, 18: 34806
JUNGNER, H., Investigation of reaction $K^{38}(p,\gamma)Ca^{40}$ at 1103, 1131, and 1153 kev, 18: 34784
JUNOD, P., Specific heat measurements of EuSe and EuTe, 18: 34695
JUPITER, C. P., Angular distribution of bremsstrahlung intensity for 10- and 20-Mev electrons, 18: 34459
JURA, G., High-pressure effect on Dy, 18: 33592
JURCZENKO, V., Radiation effects on Nissl granules in rat spinal cord neurons, 18: 33349
JUREWICZ, A., K^+-p scattering, 18: 34543
JURSIK, J., Decay of Re-186, 18: 34805

K

KACZMAREK, Eugenia, Electric conductivity and dielectric constant of plasma, 18: 35036
KACZMAREK, Eugenia, Problems in magnetogasodynamics. I., 18: 35028
KAELD, L., Investigation of reaction $K^{38}(p,\gamma)Ca^{40}$ at 1103, 1131, and 1153 kev, 18: 34784
KAESZ, H. D., Infrared spectra of $(CO)_5Mn$–$Re(CO)_5$, 18: 33551
KAGIYA, Tsutomu, Gamma-induced polymerization of ethylene, 18: 33649
KAGIYA, Tsutomu, Radiation-induced polymerization of 3,3-bis-chloromethylcycloxabutane, 18: 33651
KAHALAS, Sheldon L., Coupling of waves at plasma-neutral gas interface, 18: 35004
KAHANE, Joseph, Radiative corrections to π-e scattering, 18: 34563
KAHN, A. H., Electronic energy bands in $SrTiO_3$, 18: 33586
KAHN, F. D., Transverse plasma waves and their instability. II., 18: 34994
KAISER, W. C., Relative light output of plastic scintillators, 18: 33638
KAJFOSZ, Josef, Nuclear batteries, 18: 34500
KAKUTANI, Tsunehiko, Hydromagnetic stability of modified plane Couette flow in presence of transverse magnetic field, 18: 34317
KALBFLEISCH, George R., Additional properties of 959-Mev meson, 18: 34515 (UCRL-11431)
KALINA, V. K., Volumetric automatic dispenser of radioactive liquid, 18: 33653
KALINKIN, B. N., Angular distribution of products of multinucleon transfer reactions, 18: 34763 (JINR-P-1675)
KALISTRATOV, G. V., Distribution of C^{14}-labeled MPA in tissue and its elimination, 18: 33373
KALLFELZ, J. M., Reactivity absorbed by Na in SRE, 18: 35149 (NAA-SR-9509)
KALLIGA, G. P., Properties of high-purity ZrO_2, 18: 34155
KALMAN, G., Collective description of classical plasmas, 18: 34972 (ARL-64-140)
KALNAES, O., Heavy-water lattice calculations, 18: 35112 (RISÖ-81)
KAMAL, A. N., Reaction $\pi\pi \to K\bar{K}$, 18: 34534
KAMEMOTO, Y., Self-shielding effects in thermal-neutron activation of metals, 18: 33488
KAMINER, N. S., Introducing meteorological corrections into cosmic-ray intensity data, 18: 34466 (NASA-TT-F-126(p.194-214))
KAMINER, N. S., Registration of intensity of cosmic rays with plastic scintillators, 18: 33889 (NASA-TT-F-126(p.161-76)
KAMMURI, Tetsuo, Pairing correlations in excited nuclei, 18: 34930
KANAREK, T., Reaction $\pi^- + Xe \to \pi^- + \pi^0 + Xe$ for 9-Bev/c primary π^- mesons, 18: 34949
KANARIS, A. D., K_{α} μ-mesic x rays of Ca-40 and Ca-44, 18: 34900
KANAZIRSKI, Kh. M., Elastic scattering of 6.2-Bev protons on deuterons, 18: 34616
KANDA, Frank A., Phase equilibria and specific volumes of liquid metals, 18: 34131 (TID-20849)
KANE, James S., Oxidation-resistant refractory coating on dense graphite, 18: 34116
KANEKO, Tetsunosuke, Core structure in extensive air showers, 18: 34483
KANTELE, J., Isomeric state in Yb-174 (850 μsec), 18: 34896
KANTELE, J., Versatile coincidence spectrometer, 18: 33950
KAPITONOV, Yu. A., Azimuthal telescope for investigation of variations of cosmic rays, 18: 33888 (NASA-TT-F-126(p.138-60))
KAPLAN, M. H., Design and performance of ion engine systems, 18: 33699
KAPLIN, V. P., Automatically separating potato tubers from lumps of ground in harvesting machine, 18: 33991 (AEC-tr-6399(p.277-85))
KAPUL'TSEVICH, Yu. G., Statistical models of postirradiation recovery of cells, 18: 33355
KARAEV, Z. Sh., Reactions of Ce and Ga selenides, 18: 33552
KARBAN, O., Polarization measurements with protons scattered on C, 18: 34809
KARGIN, V. A., Effect of radiation on polypropylene, 18: 34243
KARLSSON, S.-E., Double-focusing β spectrometer (50 cm), 18: 33947
KARLSSON, Sven-Erik, Extension of the photoelectron method to elements of low atomic number, 18: 34414

KARNAUKHOV, V. A., Attempt to detect Ne-16 two-proton decay, 18: 34765 (JINR-P-1679)
KARNAUKHOV, V. A., Proton decay of nuclei with $Z > 50$, 18: 34767 (JINR-P-1706)
KARPFEL, Z., Effects of irradiation and of nucleic acids on chromosomes, 18: 33309
KARPINSKI, J. Z., New developments in radiation detectors, 18: 33904
KARPLUS, M., Reactive collisions in molecular beams: $K + CH_3I$, 18: 33564
KARPLUS, M., Shielding anisotropies in Xe fluorides, 18: 33558
KARPLUS, M., Theory of nuclear magnetic shielding in diatomic molecules, 18: 33563
KARULE, E. M., Scattering of electrons on Li atoms, 18: 34429
KASHY, E., Shell-model states in Ca-49, 18: 34905
KASNER, W. H., Recombination of molecular positive ions with electrons, 18: 34259 (AD-434907)
KASSIMATIS, Constantin, Correlation function analysis of systems obeying linear differential equations, 18: 35078 (TID-7679(p.321-9))
KATAOKA, Akira, Solvent extraction in TBP–HNO_3 or -HCl systems, 18: 33685
KATHREN, R. L., Double-moderator DePangher neutron dosimeter, 18: 33951
KATORI, Kenji, Deviation from 1/E distribution in epi-cadmium neutron spectrum, 18: 34735
KATSUMATA, Itsuo, Density spectrum of charged particles in EAS, 18: 34484
KATSUMORI, Hiroshi, Mass spectra of baryons, mesons, and leptons, 18: 34603
KATSURA, Masahiro, Formation of UC_{1-x} N_x, 18: 33576
KATYSHEV, Yu. V., Catalysis of $d + d \rightarrow He^3 + n$ fusion reaction by μ^-, 18: 34617
KATZ, Robert, Phase-space occupation of electron, proton, and photon beams, 18: 34641
KAUFMAN, Charles, Recoil distribution in electron-field pair production, 18: 34439
KAUL, A., Excretion of Th in thorotrast patients, 18: 33269
KAWAMATA, Shuichiro, Plasma confinement device with reversed field. I., 18: 34993
KAZACHKOVSKII, O. D., Transient regimes of natural circulation in multicircuit reactor system, 18: 35081
KEARSEY, H. A., Heat transfer to high-pressure steam and water in annulus. VI., 18: 33730 (AERE-R-4352)
KEATON, P. W., Differential cross sections for reaction $B^{11}(d,p)B^{12}$, 18: 34909
KECKES, S., Autografts and homografts in sublethally irradiated rats, 18: 33386
KEENAN, Peter P., Microwave propagation studies in dense plasmas, 18: 35041
KEEYS, R. K. F., Heat transfer to high-pressure steam and water in annulus. VI., 18: 33730 (AERE-R-4352)
KEGEL, W. H., Spectral distribution of light scattered by a θ-pinch plasma, 18: 35010
KEILHOLTZ, G. W., Effect of fast-neutron irradiation on BeO compacts, 18: 34224
KEIRIM-MARKUS, I. B., Technique for study of shielding properties, 18: 34374
KEIZER, S. A., Change in cardio-vascular system in rabbits chronically irradiated, 18: 33364
KELBER, Charles N., Nuclear reactor with improved beam tube, 18: 35232
KELLER, Donald L., Prog. rpt. on UN, 4–6/63, 18: 34035 (BMI-X-10053)
KELLER, Douglas V., Phase equilibria and specific volumes of liquid metals, 18: 34131 (TID-20849)
KELLEY, M. T., Developments in d-c polarography, 18: 33452 (ORNL-P-145)
KELLY, Frank L., Microwave propagation studies in dense plasmas, 18: 35041
KELLY, W. H., Decay of Te-121 and Te-121m, 18: 34882
KELMAN, V. M., High-precision prism β spectrometer, 18: 33948
KEMENY, Leslie G., Stochastic models for fission reactors, 18: 35070 (TID-7679(p.29-59))
KEMMERICH, M., Two- and many-component systems with Pu. II., 18: 34125 (KFK-220)
KEMP, Toge, Chromosomal diseases and global diseases, 18: 33217
KEMPTER, Charles P., Further investigations of RuC and OsC, 18: 33572
KENEFICK, Robert A., Low-lying collective states of Sm-152 and Sm-154, 18: 34913
KENNEDY, Joseph W., Nuclear and radiochemistry, 18: 33455
KENNEDY, R. C., Finite superconductors and their infinite volume limit, 18: 34703
KENNETT, T. J., Programmer for two-dimensional pulse-height analyzer, 18: 33960
KERIMOV, B. K., Spin correlations in scattering of the neutrino and antineutrino, 18: 34614
KERMAN, A. K., Effect of quadrupole collective motions on giant dipole resonance, 18: 34908
KERMAN, A. K., Intermediate resonances and doorway states, 18: 34768 (MIT-2098-61)
KERN, C. W., Shielding anisotropies in Xe fluorides, 18: 33558
KERSLAKE, William R., Heavy-molecule propellants in electron-bombardment thrustor, 18: 33696 (NASA-TN-D-2401)
KESHOCK, Edward G., Nucleate boiling under normal and reduced gravity conditions, 18: 33736 (NASA-TN-D-2299)
KESSLER, W. V., Lean body mass from K-40 measurements, 18: 33487
KESTEN, Harry, Number of self-avoiding walks. II., 18: 34312
KHACHATUROV, Yu. G., Radioactive method for analysis of S liquid oil products, 18: 33472 (AEC-tr-6399(p.98-114))
KHACHATURYAN, M. N., Pulse amplitude analysis with photography, 18: 33893
KHALIFA, H., Reaction between Hg(II) and CDTA, 18: 33507
KHAN, M. P., Performance of electrogasdynamic generators, 18: 34501
KHARITONOV, A. S., Automatic coordination of operation of machines for delivery of coke, 18: 33987 (AEC-tr-6399(p.202-6))
KHARITONOV, A. S., Control of mineral impurities in coal using radiation, 18: 33467 (AEC-tr-6399(p.51-60))
KHARITONOV, Yu. I., Many-nucleon system in shell-model potential, 18: 34826
KHAZANOV, B. I., Selection of α emitter thickness for low-level radioactive probe spectrometry, 18: 33894
KHEIKER, D. M., Control-measuring instruments with radiation in building-materials industry, 18: 33852 (AEC-tr-6399(p.196-201))
KHOKHLOV, Yu. A., Photoneutron spectra from Pt, Bi, Pb, and U, 18: 34945
KHOLODOV, Yu. A., Development of conditioned reflex to radiation in fish and rabbits, 18: 33366
KHOMOV, F. I., Penetration of U from U–Nb–Zr alloy into Mo by diffusion, 18: 34174
KHRISTIANSEN, G. B., Energy spectrum and composition of cosmic rays of galactic and metagalactic origin, 18: 34491
KHUTROV, L. M., Radioactive contamination of seas and oceans, 18: 33779
KIEDAISCH, Warren I., Water chemistry at Dresden nuclear power station, 18: 35185
KIELBINSKI, J., MGD phenomena in the case of pulsating combustion, 18: 34296
KIENEL, Gerhard, Developments in the ultra-high vacuum field, 18: 33761
KIHARA, Taro, Energy loss by sequence of fast charges in plasma, 18: 34996
KIKER, W. E., Time-of-flight measurements of fission fragments with semiconductor detectors, 18: 33955
KIKKAWA, Shizuo, The void and hole effect in D_2O-moderated reactor, 18: 35083
KIKUCHI, Michio, Structure in a Mg–Zr alloy, 18: 34182
KIKUGAWA, Masayoshi, Analysis of low-energy π-N scattering, 18: 34604
KIKUGAWA, Masayoshi, Effects of f_5-meson on πN scattering, 18: 34611
KILPATRICK, J. N., Yankee. An operating history, 18: 35175
KIM, C. J., Diagnosis and treatment of cancer with radioactive isotopes. I., 18: 33438
KIM, C. O., Composition of secondary particles produced in nuclear interaction at ~10^{13} ev, 18: 34492
KIM, C. O., Properties of very high-energy inelastic processes from measurements on recoil baryon, 18: 34632
KIM, H. C., Cross sections for $O^{16}(d,p_0)O^{17}$, $O^{16}(d,p_1)O^{17*}$ and $O^{16}(d,\alpha_0)N^{14}$, 18: 34860
KIM, Ho Gil, Depolarization of deuterons in sector-focused cyclotron, 18: 34378
KIM, S. K., Diagnosis and treatment of cancer with radioactive isotopes. I., 18: 33438
KIM, Y. S., ϕ-ω mixing angle, 18: 34574
KIMURA, Hirozo, Production of crude Nb metal, 18: 34067
KING, W. J., Junction counters produced by ion implantation doping, 18: 33921
KINGSTON, A. E., Van der Waals forces for inert gases, 18: 34345
KIRILLOVA, L. F., Elastic p-p scattering at 8.3 Bev, 18: 34508 (JINR-P-1674)
KIRKPATRICK, W. J., Preparation of high-purity BeO powder, 18: 34064
KIRSCHBAUM, A. J., Fission distribution in seven-pin cluster fuel elements, 18: 35131
KIRYU, Kiyomi, Hitachi Training Reactor (HTR), 18: 35224
KIRYUKHIN, V. A., Control device for using modulated radioactive radiation, 18: 33843 (AEC-tr-6399(p.1-9))
KIRYUSHCHENKOV, A. P., Effects of radiation on ovaries, pregnancy, and the fetus, 18: 33395
KISIELESKI, Walter E., Liquid scintillation counting, 18: 33220

KISLIUK, P., Spectrum of Er^{3+} in single crystals of Y_2O_3, 18: 34305
KISS, Z. J., Rare earth–alkaline earth halide systems, 18: 33571
KISTEMAKER, J., Excitation of He by protons, 18: 34445
KJEKSHUS, Arne, Crystal structure of $NbTe_4$, 18: 34136
KJEKSHUS, Arne, Structural properties of $Nb_{1+x}Se_2$ phase, 18: 34137
KJELLMAN, J., Independence of the velocity of light of the motion of the light source, 18: 34294
KJEMTRUP, Jens E., Safety in reactor design, 18: 35121
KLEITMAN, D. J., Baryon resonances in W, symmetry, 18: 34553
KLENER, Vladislav, Leukemias in subjects exposed to ionizing radiation, 18: 33347
KLEPFER, Harold H., Nuclear fuel elements, 18: 35137
KLIMEK, M., Origin of giant cells after irradiation, 18: 33405
KLIMOVA, S. P., Radioprotective properties of ACTH, 18: 33411
KLINGENSMITH, R. W., Detection and identification of nuclear bursts, 18: 34251
KLINK, W. H., Finite and disconnected subgroups of SU_3, 18: 34529
KLOEPPEL, Peter K., Interactions of stopping negative pions with deuterium, 18: 34634
KLOSTERMAN, J. E., Electrorefining Be, 18: 34031 (BM-RI-6489)
KLUMB, Ralph, Prog. rpt. on steam separation technology, 4–6/64, 18: 33693 (ACNP-64026)
KNIFFEN, D. A., Modulation of low-energy galactic cosmic-ray H and He, 18: 34482
KNIGHT, Leslie James, Improvements in block structures, 18: 35096
KNIGHT, W. D., Superconducting behavior of superimposed thin films of Al and Sn, 18: 34723
KNOF, Hans, Diffusion cross sections for N^+–N and O^+–O collisions, 18: 34418
KNYAZEVA, R. A., Changes in sorption properties of brain and kidney tissues after doses of U-235 fission products, 18: 33358
KOBAYASHI, Akio, Radiation effects on *Toxoplasma gondii*, 18: 33331
KOBAYASHI, Keisuke, Backscattering of γ rays from Fe slabs, 18: 35054
KOBAYASHI, Shinsaku, Fast neutron time-of-flight system, 18: 33944
KOBE, Donald H., Self-energy of Bogoliubov quasi particle, 18: 34687
KOCH, D., Refractory metals for production of superconductors, 18: 34179
KOCH, D. W., Corrosion behavior of ATR materials of construction, 18: 34074 (IDO-24460)
KOCH, K.-H., Determination of small gas content in metals, 18: 33491
KODA, Shigeyasu, Structure in a Mg–Zr alloy, 18: 34182
KOH, C. S., Diagnosis and treatment of cancer with radioactive isotopes. I., 18: 33438
KOIDE, Minoru, Sedimentary profile across the North Atlantic, 18: 33790
KOIKE, Masahiro, Numerical differential cross sections of $Ca^{44}(p,d)Ca^{39}$ at 55 Mev, 18: 34757 (INSJ-72)
KOLKER, H. J., Theory of nuclear magnetic shielding in diatomic molecules, 18: 33563
KOLODKEVICH, A. D., Automatization of cycle of crushing and classification of ores using isotopes, 18: 33988 (AEC-tr-6399(p.227-42))
KOLOMIETS, O. D., Effect of γ irradiation of seeds on extracts of sugar beet leaves, 18: 33314
KOMAR, Arthur, Four-dimensional baryon space and quarks, 18: 34588
KOMAROV, V. V., Breakup of a deuteron by a nucleon, 18: 34535
KOMAROV, V. V., Four-body problem at low energies, 18: 34619
KOMORI, Takuji, Isotopic exchange reaction between U(IV) and U(VI) ions. I., 18: 33577
KONDRASHENKO, A. N., Nonlinear theory of electron cyclotron resonance, 18: 34988
KONDRAT'EV, L. N., New data on W-182 excited states, 18: 34953
KONDRAT'EVA, G. V., Damage to DNA structure *in vitro* by γ radiation, 18: 33356
KONECNY, K., Interaction of deuterons and Li and occurrence of γ radiation, 18: 34806
KONEV, V. N., Reaction diffusion in metal–complex gas systems. VII., 18: 34146
KONIN, A. D., Transition of μ^- mesons from proton to C, 18: 34947
KONOPLEV, K. A., Ion-exchange unit for production of reactor feed water, 18: 33713
KOONTZ, R. L., Indium-115 thermal cross section ratios, 18: 34884
KOONTZ, R. L., Nondestructive determination of U-235 content of SNAP fuel rods. II., 18: 34044 (NAA-SR-9600)
KOPALEISHVILI, T. I., Absorption of π^- mesons and correlation of nucleons in light nuclei, 18: 34851
KOPECKY, Jiri, Nuclear batteries, 18: 34500
KOPPEL, Juan U., Neutron scattering by H_2O, 18: 34739
KOROGODIN, V. I., Statistical models of postirradiation recovery of cells, 18: 33355
KORZUN, A. A., Gamma exposure meter, 18: 33854 (AEC-tr-6399(p.221-6))
KOSSANYI-DEMAY, P., Excitation of levels of N-14 by electron scattering, 18: 34825
KOSSON, R., Electrothermal arc-jet propulsion system, 18: 33706
KOSTIC, E., Sintering process for UO_2 according to Pines theory, 18: 34048 (NP-14124)
KOT, G. A., Geochemistry of Th in syenites, 18: 33797
KOTIK, I. I., Radioactive density meter, 18: 33848 (AEC-tr-6399(p.138-52))
KOTORLENKO, L. A., Investigation of oxidative destruction of polyamides. I., 18: 33668
KOUL, O. N., Interaction of 14-Mev neutrons with Ca, 18: 34841
KOVACH, A., Fission-product precipitation in Hungary, 18: 33771
KOVALEV, E. E., Technique for study of shielding properties, 18: 34374
KOVRIZHNYKH, L. M., Interaction of longitudinal and transverse waves in plasma, 18: 35025
KOWAL, G., Point-to-point kernel analysis to determine wall penetration of γ radiation, 18: 35055
KOWALCZYK, M., Chromosomal abnormalities in the golden hamster induced by x rays, 18: 33322
KOWALSKI, E., Radiation effects on biosynthesis of heme, 18: 33400
KOYAMA, Kinji, Prompt neutron lifetime in a reflected system, 18: 35116
KOZIRENKO, V. E., Two-dimensional flow in magnetogasdynamics, 18: 34321
KOZLOV, F. A., Thermodynamic calculations of reaction of Na and H_2O, 18: 33528 (NP-14080)
KRANTZ, S. B., Effect of erythropoietin upon heme synthesis by marrow cells, 18: 33242
KRASIL'NIKOV, D. D., Meteorological effects in relation to frequency of extensive air showers, 18: 34473 (NASA-TT-F-126(p.280-5))
KRASIL'NIKOV, D. D., Origin of large ionization bursts, 18: 34474 (NASA-TT-F-126(p.286-91))
KRASIL'NIKOV, D. D., Temporal variations of different components of cosmic rays, 18: 34463 (NASA-TT-F-126(p.81-101))
KRAUSS, Morris, Gaussian correlation functions, 18: 34427
KREBS, Karlheinz, Low-frequency vibrations of crystalline biphenyl, 18: 34302
KRIGMAN, F. E., Analysis of ternary mixtures in ionization gas analyzers, 18: 33471 (AEC-tr-6399(p.92-7))
KRIMIGIS, S. M., Solar protons and their geophysical effects, 18: 34388
KRISHCHYAN, V. M., Polarization of cosmic muons, 18: 34490
KRISTOV, L. C., Elastic scattering of 6.2-Bev protons on deuterons, 18: 34616
KRITZ, Arnold, Ionizing shock wave interacting with EM field, 18: 34333
KRIVCHIKOV, A. P., Measurement of humidity of friable bodies by neutron slowing-down method, 18: 33470 (AEC-tr-6399(p.83-91))
KRIVITSKII, M. D., Analysis of ternary mixtures in ionization gas analyzers, 18: 33471 (AEC-tr-6399(p.92-7))
KRIZ, J., Radiation effects on ketone extraction. II., 18: 33621 (UJV-977/64)
KRONAST, B., Spectral distribution of light scattered by a θ-pinch plasma, 18: 35010
KRONE, R. W., Interference effects in $Li^7(p,\gamma)Be^8$ reaction, 18: 34875
KROUSE, H. R., Fractionation of Ge isotopes in chemical reactions, 18: 33626
KRUEGER, David A., Electromagnetic structure of the 3-nucleon system, 18: 34912
KRUGLOV, R. N., Radioactive liquid analyzer, 18: 33473 (AEC-tr-6399 (p.115-23))
KRUGLYKH, A. A., Evaporation during thermal dissociation of Yb and La beryllides, 18: 34154
KRUPKE, W. F., Spectrum of Er^{3+} in single crystals of Y_2O_3, 18: 34305
KRUPKE, William F., Energy levels of Er^{3+} in LaF_3, 18: 33562
KRUSHINSKAYA, N. P., Radiolysis of thymidine, 18: 33658
KUBASCHEWSKI, O., Thermochemistry of refractory metals, 18: 33603
KUBOTA, Tadashi, Thermal conductivity of UO_2, UC, and UC_2, 18: 34172
KUCHARCZYK, Piotr, Magnetogasdynamic theory of flow, 18: 35035
KUCHARCZYK, Piotr, Problems in magnetogasdynamics. I., 18: 35028
KUEHNE, Barbara M., Low-temperature dynamic nuclear polarization, 18: 34717
KUEHNER, J. A., Levels of Ne-20, 18: 34842
KUEHNER, J. A., New α-emitting levels in Ne-20, 18: 34958
KUESER, P. E., Prog. rpt. on materials for space power systems, 12/63–2/64, 18: 34046 (NASA-CR-54041)
KUKAVADZE, G. M., Spectrometric determination of microquantities of B in materials, 18: 33479
KUKHTEVICH, V. I., Spatial distribution of dose of scattered γ radiation, 18: 33810
KULISHENKO, A. Z., Automatic coordination of operation of machines for delivery of coke, 18: 33987 (AEC-tr-6399(p.202-6))
KULISHENKO, A. Z., Control of mineral impurities in coal using radiation, 18: 33467 (AEC-tr-6399(p.51-60))
KULKA, M., Total dose intensity of fission products, 18: 33633
KULLER, Robert G., Dynamics of ionized media, 18: 34971 (ARL-64-85)
KULP, J. Laurence, Origin of the Colorado Plateau U ores, 18: 33796
KUMAR, Ashok, Effect of shock on susceptibility of magnetite grout

mixture, 18: 34284 (UCRL-13088)
KUME, Kiyoshi, Nuclear magnetic resonance in nickel fluosilicate, 18: 34275 (NP-14114)
KUNZE, H. J., Spectral distribution of light scattered by a θ-pinch plasma, 18: 35010
KUREPIN, A. B., Elastic scattering of protons by H-3, 18: 34944
KURMAEV, F. A., Measurement of humidity of friable materials by neutron method, 18: 33466 (AEC-tr-6399(p.43-50))
KURODA, Y., Noise analysis of reactor systems, 18: 35073 (TID-7679 (p.155-69))
KUROHARA, Samuel S., Microangiography as a technique, 18: 33289
KUROI, Hideo, Prompt neutron lifetime in a reflected system, 18: 35116
KUROI, Hideo, Self-shielding factor of resonance foils, 18: 34737
KUSHIMA, Isao, Extraction and separation of Ta and Nb, 18: 33688
KUSNISS, J. H., Positron annihilation in divalent metallic oxides, 18: 33605
KUSUKAWA, Ken-ichi, Kutta-Joukowski condition in magnetohydrodynamics, 18: 34316
KUSZELL, A., Kinetic equation for an inhomogeneous plasma, 18: 34995
KUTZELNIGG, Werner, Natural expansion coefficients of many-electron wave functions. I., 18: 33554
KUWABARA, Sinzi, Similarity solutions for transient pinched plasma. II., 18: 34997
KUZIN, A. M., Application of radiations in hydroponics, 18: 33997
KUZMA, Dennis C., MHD bearings, 18: 33715
KUZMA, Yu. B., Crystal structure of Nb–Co β phase, 18: 34145
KUZ'MIN, A. I., Temporal variations of different components of cosmic rays, 18: 34463 (NASA-TT-F-126(p.81-101))
KWIRAM, Alvin L., Establishment of the quantized flux state, 18: 34709
KYCIA, T. F., Structure in π-p total cross section, 18: 34584
KYNAST, G., Chelate-forming exchanger resins. V., 18: 33508

L

LACASSAGNE, A., Changes produced in rat liver by irradiation. I., 18: 33380
LADNER, H.-A., Modification of radiation damage in rats by splenectomy, 18: 33415
LADNER, H.-A., Radioprotection efficiency of histamine in mice, 18: 33414
LADO, F., Perturbation correction to radial distribution function, 18: 34344
LAFFON, Jean-Louis, Improvements in devices for measuring small magnetic fields, 18: 33870
LAFOUCRIERE, J., Calculation of (n,α) angular distributions, 18: 34876
LAFOUCRIERE, J., Determination of polar profile of synchrocyclotron magnet, 18: 34376
LAFUMA, J., Physicochemical form of radioelements, 18: 33590
LAI, K. W., Decay modes and properties of the X^0, 18: 34592
LAI, M. G., Determination of Ce-141 and Ce-144 in fission-product mixtures, 18: 33465 (USNRDL-TR-756)
LAITHWAITE, John Michael, Improvements relating to reactor fuel assemblies, 18: 35132
LALETIN, N. I., Slow neutrons in H_2O with absorbers, 18: 34733
LAMBE, J., Quantum interference effects in superconductors, 18: 34696
LAMBERTS, H. B., Radiomimetic toxicity of ozonized air, 18: 33334
LAMERTON, L. F., Radiation carcinogenesis, 18: 33299
LANDAUD, Gilbert, Mean life of unstable states of daughters of radioelements, 18: 34770 (NP-14115)
LANDAUER, Gerd, Emission of cyclotron-harmonics, 18: 34362
LANDE, A., Nuclear pairing force hamiltonian and projected wave functions, 18: 34959
LANDER, Richard L., ρ Exchange mechanism in reaction $\pi^+ + p \rightarrow N^{*++}_{33} + \pi^0$, 18: 34626
LANDER, Richard L., T = 2 pion-pion interaction, 18: 34630
LANE, A. M., Radial distribution of the absorption potential, 18: 34854
LANG, Donald W., Isolated eigenvalue of random matrix, 18: 34023
LANG, Peter M., Atomic Energy in Switzerland, 18: 35082
LANGDON, W. R., Radiation effects handbook, 18: 34245
LANGE, Olaf Harald Vilhelm, Method of operating pressure water-cooled atomic reactor, 18: 35190
LANGER, B. F., Fatigue design basis for Zy components, 18: 34233
LANPHERE, M. A., Redistribution of Sr and Rb isotopes during metamorphism, 18: 33793
LANZL, L. H., Radiation accidents and emergencies, 18: 33817
LA PAZ, L. J., Full-scale submarine test facility, 18: 33709 (SC-TM-64-636)
LAPKOVSKAYA, N. I., Automatically separating potato tubers from lumps of ground in harvesting machine, 18: 33991 (AEC-tr-6399(p.277-85))
LAPORTE, Otto, Reflection of strong blast waves, 18: 34324
LARANJEIRA, M. F., Saturation backscattering of β particles, 18: 35057
LARIN, P. P., IR spectra of acrylonitrile–α-methylfuran copolymers, 18: 33670
LARKIN, A. I., Electrodynamics of superconductors, 18: 34720
LARKIN, F. M., Computer programs for numerical study of magnetic fields, 18: 34266 (CLM-R-31)
LARSON, John W., Prog. rpt. on spacecraft and powerplant integration, 10/26/63–4/26/64, 18: 35197 (64SD700)
LASSILA, K. E., Crossing and anticrossing effects in optical resonance fluorescence, 18: 33656
LASSMANN, G., Radiation-induced radical formation in water–aminoacid system, 18: 33675
LATHAM, W. N., Dependence of H-I curve of Nb–Zr wire on temperature, 18: 34681 (BSD-TDR-64-87)
LATHROP, K. A., Nuclear needle for use in neurosurgery, 18: 33436
LATORRE, C. O., Determination of radioactivity of minerals by x rays, 18: 33794 (NP-14176)
LAUE, H.-J., Deformation of Zr sheets during oxidation, 18: 34081
LAUER, R. S., Separation of rare-earth elements into subgroups, 18: 33689
LAUGHLIN, John S., Patient simulation in x-ray therapy, 18: 33435
LAUGHLIN, John S., Prog. rpt. on metabolic studies with Ca-47, 5/63–5/64, 18: 33232 (NYO-910-3)
LAUGHLIN, John S., Prog. rpt. on free radical production and secondary electron spectra, 5/63–5/64, 18: 33274 (NYO-910-1)
LAUGHLIN, John S., Prog. rpt. on radiation mechanisms in biological systems, 5/63–5/64, 18: 33275 (NYO-910-2)
LAURENT, R., Portable plant for decontamination of buildings and equipment, 18: 33800 (EUR-1821.f)
LAVERRIERE, Roger, Production of secondary particles in interactions of elementary particles, 18: 34509 (NP-14086)
LAWRENCE, L. G., Energy levels of Na-22, 18: 34821
LAWSON, A. W., Superconducting energy gap in Tl, 18: 34701
LAZAR, James, Survey of space nuclear propulsion, 18: 35216
LAZDINS, D., Shielding anisotropies in Xe fluorides, 18: 33558
LAZZARINI, E., Activation analysis of D by $C^{13}(d,n)N^{13}$ reaction, 18: 33486
LEBEDEV, A. M., Interaction cross section and energy conserved by nucleons in collisions, 18: 34952
LEBEDEV, A. T., Automatization of cycle of crushing and classification of ores using isotopes, 18: 33988 (AEC-tr-6399(p.227-42))
LEBEDEV, A. T., Gamma exposure meter, 18: 33854 (AEC-tr-6399(p.221-6))
LEBEDINSKI, A. V., Biological effects and RBE of high-energy protons, 18: 33286 (UCRL-Trans-1068)
LE BIHAN, R., Cesium plasma capillary emitter as source of Cs ions, 18: 34502
LE BLANC, M. A. R., Behavior and structure of flux jumps in hard superconductor, 18: 34724
LECHACZYNSKI, M., High stability multiparametric modular circuitry at Saclay's cyclotron, 18: 33936
LECKY, James A., Catalog of nuclear reactor concepts. Pt. I, Sec. I, 18: 35119 (ANL-6892)
LE COROLLER, Y., Thick junctions made with nuclear-compensated Si, 18: 33920
LE COUTEUR, K. J., Fluctuations in nuclear cross sections, 18: 34893
LEDENTSOV, Yu. K., Spectra of blood serum absorption with ionizing radiation and low temperature, 18: 33335
LEDIN, E., Drive mechanism, 18: 35110
LEE, B. W., Equivalence of elementary and composite particles, 18: 34522
LEE, J. E., Jr., Effect of fast-neutron irradiation on BeO compacts, 18: 34224
LEE, J. H., Flux transport by shock plasma, 18: 35007
LEE, J. K., Diagnosis and treatment of cancer with radioactive isotopes. I., 18: 33438
LEE, M., Diagnosis and treatment of cancer with radioactive isotopes. I., 18: 33438
LEE, R. A., Radiolysis of gaseous HCl, 18: 33625
LEE, S. M., Ligand field spectra of some new laser chelates, 18: 33565
LEFEBVRE-BRION, H., Hyperfine splitting of ^3D levels of He-3, 18: 34903
LEFEVRE, H. W., Tunnel-diode time mark generator, 18: 33857
LEGOWSKI, S., Relaxation of optically pumped Cs atoms, 18: 33566
LEHMANN, C., Photochemical rearrangement of steroids, 18: 33635
LEHNERT, Bo, Heat and momentum balance of plasma slab, 18: 34987
LEHR, S. N., Nuclear test detection spacecraft, 18: 33703
LEICHNAM, Jean Pierre, Luminous sources for U isotope measurements by emission spectrometry, 18: 33459 (CEA-R-2428)
LEICHT, Edith, Apparatus for determination of H content in Ti and Zr, 18: 33511
LEIN', R. A., Control device for using modulated radioactive radiation, 18: 33843 (AEC-tr-6399(p.1-9))
LEITNER, J., Decay modes and properties of the X^0, 18: 34592
LEITTEN, C. F., Jr., Fabrication of U_3O_8–Al composite fuel plates, 18: 34087 (ORNL-3644)
LEJSEK, K., Effect of x irradiation *in vitro* on formation of oxidation

products of lipids, 18: 33305
LEMMER, R. H., Intermediate resonances and doorway states, 18: 34768 (MIT-2098-61)
LEMPICKI, A., Laser phenomena in Eu chelates. IV., 18: 33561
LENK, R., Angular dependence of spin densities on protons of CH_2 group, 18: 33548
LENNES, G., Radioprotective effect of chlorides of Na, Ca, and Mg on barley, 18: 33409
LENNON, J. J., Positive ion mobilities and conversion rates in He afterglow, 18: 34351
LENZ, William H., Powdered tantalum articles, 18: 34117
LEONARD, A., Descendants of rats irradiated at a young age, 18: 33312
LEONE, Charles A., Paper-chromatographic separations of fragments from γ-irradiated ovalbumin, 18: 33499
LEONE, David P., Construction of complete isodose distributions in Co teletherapy, 18: 33445
LEONHARDT, Wolfgang G., Determination of O in GaAs by neutron activation, 18: 33541
LEONTIC, B. A., Structure in π-p total cross section, 18: 34584
LEROUGE, Bernard, Fuel elements for reactors, 18: 35231
LESS, N., Influence of O on U–H_2O reaction. III., 18: 34072 (AWRE-O-40/64)
LESSMANN, G. G., Prog. rpt. on weldability and elevated temperature stability of refractory metal alloys, 12/21/63–3/21/64, 18: 34058 (WANL-PR(P)-003)
LESTER, William A., Jr., Gaussian correlation functions, 18: 34427
LESTIBOUDOIS, Guy, Improvements in reactor fuel element, 18: 35133
LE SURF, J. E., Corrosion treatment for cooling water circuits, 18: 35063 (IG-Report-52)
LEVENSON, Stanley M., Effect of D_2O on wound healing, collagen, and metabolism, 18: 33250
LEVEREAULT, L. A., Discrimination of seismic signals from earthquakes and explosions, 18: 33765 (AD-437784)
LEVESQUE, D., Integral equation for classical fluids, 18: 34336
LEVIN, Betsy, Deuterium content of phenocrysts, 18: 33788
LEVINE, Howard B., Hartree-Fock wave function of atomic and molecular systems, 18: 34426
LEVINSON, L. S., Heat content of molten U, 18: 33553
LEVINSTEIN, M. A., Corrosion resistance of refractory metals, 18: 34084
LEVY, R. H., Hypersonic magnetohydrodynamics with or without blunt body, 18: 34272 (NASA-CR-88)
LEWIS, Walter, Phospholipid patterns in livers accumulating fat, 18: 33493
LEY, R., Inner-outer exchange interactions of TlF molecule, 18: 34936
LEYENDECKER, A. J., Electronic energy bands in $SrTiO_3$, 18: 33586
LI, C. H., Dislocation configurations and initiation of yielding in MgO, 18: 34123 (HR-64-269)
LI, Ch'i, Preparation of Mo single crystals, 18: 34061 (FTD-TT-64-350)
LIAS, S. G., Proton-transfer reactions between H_3^+ and saturated hydrocarbons, 18: 33639
LIBBY, W. F., Intense 584-Å light from simple continuous He plasma, 18: 35012
LIBBY, W. F., Radiocarbon date discrepancies, 18: 33789
LIBBY, W. F., Superconductivity in the artificial metals, 18: 34707
LICHTIN, Norman N., Effect of O on radiolysis of liquid methanol. III., 18: 33618 (CONF-322-14)
LIEB, E. H., Two-dimensional Ising model, 18: 34356
LIEDEL, A. L., STAT-3: interpretive program for logical operations, 18: 35244 (KAPL-M-6165)
LIHL, F., Preparation of rare earth–Mn–Hg alloys, 18: 34028 (AD-430037)
LIHL, F., Rare earth–Mn alloys, 18: 34027 (AD-428772)
LIHL, F., Yttrium–Mn and Gd–Mn alloys, 18: 34026 (AD-428771)
LIJBRINK, E., Particular properties of metals in reactor engineering, 18: 34181
LIJBRINK, E., Steel irradiation program, 18: 34219 (RCN-26)
LINARES, E., Determination of radioactivity of minerals by x rays, 18: 33794 (NP-14176)
LINCOLN, J. Virginia, Geomagnetic and solar data, 18: 34391
LIND, Don Leslie, Distribution of charge-exchange and inelastic neutrons in π^--p interactions, 18: 34516 (UCRL-11435)
LINDAHL, Charles B., Chemistry of P_2Cl_4, 18: 35254 (UCRL-11189)
LINDAUER, R. B., Reactor safety analysis, MSRE design, 18: 35152 (ORNL-TM-732)
LINDELL, A., Excretion of estrogens and steroids in irradiated cervical carcinoma, 18: 33287
LINDELL, Bo, Building material for low-radioactivity laboratories, 18: 35050
LINDERBERG, Jan, Cohesive energy of solid Ne, 18: 34413
LINDERBERG, Jan, Penetration effects in ^3F series of CsI, 18: 33579
LINDSEY, James S., Production of $\Xi K(n)\pi$, $\Lambda K\bar{K}(n)\pi$, and $\Sigma K\bar{K}$ final states, 18: 34514 (UCRL-11430)
LINDSEY, James S., Ξ^*(1530-Mev) spin and parity, 18: 34517 (UCRL-11436)
LINDSKOG, J., Ground-state rotational band of Tm-169, 18: 34794
LINDSKOG, J., Lifetime of the 138.9-kev level in Tm-169, 18: 34795
LINDSKOG, J., Two lifetimes in ground-state rotational band of Tm-171, 18: 34796
LINDSTROEM, J. O., Ground-state rotational band of Tm-169, 18: 34794
LINDSTROEM, J. O., Lifetime of the 138.9-kev level in Tm-169, 18: 34795
LINDSTROEM, J. O., Two lifetimes in ground-state rotational band of Tm-171, 18: 34796
LINEBERGER, W. C., Prog. rpt. on ionization of alkali ions by electron impact, 3–5/64, 18: 34406 (TID-20877)
LINEV, A. F., Formation of fissioning isomer in capture of neutrons by Am, 18: 34759 (JINR-D-1693)
LINK, Leonard E., Reactor technology, selected reviews—1964, 18: 35159 (TID-8540)
LINLOR, William I., Absorption of laser light by plasma, 18: 35039
LIPKIN, H. J., Unitary symmetry in meson-baryon reaction, 18: 34585
LIPMANOV, E. M., Existence of heavy, charged lepton, 18: 34615
LISKA, B., Relation between radioresistivity of bacteria and their content of nucleic acids and proteins, 18: 33310
LISKIEN, H., Prog. rpt. on cross section measurements of neutron-induced threshold reactions, 5/64, 18: 34753 (EANDC(E)-50(L))
LISSAK, Edward E., Glass microdosimetry system, 18: 33880 (NDL-SP-4)
LITTLE, W. W., Jr., Startup of solid core nuclear rockets, 18: 35213
LITTLETON, William, Prog. rpt. on steam separation technology, 4–6/64, 18: 33693 (ACNP-64026)
LIU, L., Excitation spectrum in liquid He II, 18: 34702
LIU, Lu Sun, Excitation spectrum in liquid He II, 18: 34702
LIU, Lu Sun, Vector-meson production in meson-baryon collisions, 18: 34567
LLOYD, E., Assessment of radioactive body burdens, 18: 33261
LLOYD, William A., High-vacuum sputter-ion gettering apparatus, 18: 33875
LOBANOV, E. M., Determination of composition of mixtures by β rays, 18: 33469 (AEC-tr-6399(p.72-82))
LOCKHART, Luther B., Jr., Determining Rn concentration in air near ground, 18: 34257
LOCKHART, R. W., Prog. rpt. on sodium mass transfer, 1–6/63. XI., 18: 34073 (GEAP-4438)
LOCKWOOD, J. A., Neutron albedo measurements on polar orbiting satellites, 18: 34478
LOEWENSTEIN, Walter B., Fast reactor core, 18: 35105
LOGACHEV, Yu. I., Variations of cosmic rays at 9 to 12 kilometers, 18: 34464 (NASA-TT-F-126(p.180-6))
LOKAN, K. H., Reaction $Si^{30}(\gamma,p)Al^{29}$, 18: 34901
LOMONOSOV, V. V., Vibration-rotational interaction in deformed nuclei, 18: 34950
LONDON, G. W., Decay modes and properties of the X^0, 18: 34592
LONGINOTTI, L. D., Resistivity of Mo–Nb and Mo–Re alloys, 18: 34183
LONSKII, E. S., Connections between local operators and the scattering matrix, 18: 34541
LOOMIS, B. A., Swelling of irradiated U–Zr alloys on annealing, 18: 34234
LOTTES, P. A., Boiling "burnout" for reactor design, 18: 35162 (TID-8540(p.131-76))
LOUCK, J. D., Eigenfunctions of Boltzmann collision operator, 18: 34331
LOVE, L. O., Prog. rpt. on isotopic separations, 1–3/64, 18: 34005 (ORNL-TM-879)
LOVE, W. J., Thermal stress analysis of tube joint for "N" reactor, 18: 33694 (HW-76850)
LOVELL, Bernard, Radio-emitting flare stars, 18: 34395
LOWDE, R. D., Exchange parameters in Fe–Ni alloys, 18: 34187
LOWENSTAM, Heinz A., Sr/Ca ratio of skeletal aragonites, 18: 33259
LOZHKIN, O. V., Angular correlation between fragments in multiple formation, 18: 34940
LU, Si-tin, Attempt to detect Ne-16 two-proton decay, 18: 34765 (JINR-P-1679)
LUBE, E. Ya., Control-measuring instruments with radiation in building-materials industry, 18: 33852 (AEC-tr-6399(p.196-201))
LUBOSHITS, V. L., Method for determining magnetic moment of Σ^+ hyperon, 18: 34623
LUCA, Emil, Polarization effects in dielectrics irradiated with x rays, 18: 33622
LUCAS, Henry F., Jr., Rigorous least-squares analysis of complex γ spectra, 18: 33926
LUCHKOV, B., Streamer chamber, 18: 33965
LUIPPOLD, H. E., Chromosome splitting, 18: 33318
LUKASH, N. I., Effectiveness of DTPA in contamination by lethal doses of Ce-144, 18: 33417
LUNDEN, Allyn O., Seed radiosensitivity, 18: 33384
LUNDEN, Arnold, Electrolysis of solid Li sulfate, 18: 33596
LUNDIN, A. G., Proton resonance in UO_4 hydrates, 18: 33602
LUNDIN, Frank E., Jr., Cancer mortality among underground metal

miners, 18: 33813
LUR'E, K. A., Conductivity distribution in fluid in external magnetic field, 18: 34358
LUSH, G. J., Polarization analyzer for protons, 18: 33949
LUSHBAUGH, C. C., Whole-body retention of I-131 in box turtles, 18: 33254
LUTSKER, L. S., Achromatic field of vision in persons working with radiation, 18: 33341
LUZOV, A. A., Barometric coefficient of neutron component, 18: 34467 (NASA-TT-F-126(p.215-19))
LUZZI, T. E., MGD boundary conditions at a conducting wall, 18: 35005
LUZZIO, Anthony J., Electrophoretic patterns from x-irradiated blood serums, 18: 33353
LYALL, E., Heater for graphite channel oxidation experiment, 18: 33711 (AERE-M-1373)
LYASH, A. V., Excitation of Ne atoms by electrons, 18: 34430
LYKOUDIS, Paul S., Magnetofluidmechanic blast waves, 18: 34329
LYNCH, Edward J., Radioactive materials around cavity of underground nuclear detonation, 18: 33766 (HNS-1229-47)
LYNCH, F. J., Lifetimes of $d_{5/2}$ hole states in Sc isotopes, 18: 34923
LYNCH, Frank J., Solid-state time-to-pulse-height converter, 18: 33930
LYNCH, J. F., Refractory ceramics of interest in aerospace structural applications, 18: 34129 (RTD-TDR-63-4102(Suppl. I))
LYNCH, James J., Survey of space nuclear propulsion, 18: 35216
LYONS, M. F., Uranium dioxide thermal conductivity from irradiations with central melting, 18: 34215 (GEAP-4624)
LYONS, S., Electron bombardment and contact ion engines, 18: 33698
LYTTON, J. L., Tensile flow behavior of Mo, 18: 34194
LYUTSAREVA, L. A., Properties of high-purity ZrO_2, 18: 34155

M

MAC DONALD, Gordon J. F., Radioactivity of the earth, 18: 33774
MAC DONALD, J. C. F., Radioisotopes—how much regulation needed?, 18: 33994
MAC DONALD, W. M., Antisymmetrization of unified nuclear reaction theory. II., 18: 34773 (NP-14190)
MAC DOWELL, S. W., Unitarity bounds of the scattering amplitude and the diffraction peak, 18: 34560
MACHEN, Donald Raymond, Energy conversion characteristics of brushless d-c servomotor, 18: 34498 (UCRL-11334)
MACHENSCHALK, Rudolf, Flow turning of refractory metals, 18: 34109
MACHI, Suco, Gamma-induced polymerization of ethylene, 18: 33649
MACINTYRE, John S., Radioactive source housing, 18: 33728
MACKE, W., Collective behavior of classical plasma, 18: 34982
MACKE, W., General properties of electron gases, 18: 34644
MACKINTOSH, A. R., Interaction of long wave length phonons with electrons, 18: 34454
MAC QUEEN, K. F., Effects if γ radiation on fresh strawberries, 18: 33993
MADDISON, R. N., Optical-model analysis of elastic scattering of 1-Mev neutrons, 18: 34828
MAECK, William J., Adsorption of young fission products on various surfaces, 18: 33448 (IDO-14644)
MAGHAN, M. Claude, Energies of electrons and positrons emitted at time of certain nuclear reactions, 18: 34783 (ORNL-tr-235)
MAHAN, Bruce H., Gaseous ion recombination rates. III., 18: 33555
MAHAN, G. D., Remote afterloading with intracavity applicators, 18: 33446
MAHANTHAPPA, K. T., Equivalence of elementary and composite particles, 18: 34522
MAHON-SMITH, D., Vibrational structure in some weaker systems of N_2, 18: 33568
MAILING, L., Nucleon cluster reduced widths, 18: 34891
MAISIN, J. R., Descendants of rats irradiated at a young age, 18: 33312
MAISIN, J. R., Effect of radioprotectors on radiological treatment of cancers, 18: 33407
MAISIN, J., Effect of RNA and mononucleotides on restoration of radiolesions, 18: 33410
MAJER, J., Radiometric determination of ash in vegetable drugs, 18: 33480
MAKAROV, A. N., Gamma-γ logging for discovering deposits in South Littoral, 18: 33782
MAKHUNKA, I., Alpha spectra of Tb isotopes, 18: 34766 (JINR-P-1687)
MAKHUNKA, M., Alpha spectra of Tb isotopes, 18: 34766 (JINR-P-1687)
MAKI, Kazumi, Theory of spontaneous breakdown of symmetries, 18: 34666
MAKIN, M. J., Slip dislocations and prismatic loops in Be, 18: 34168
MAKSIMENKO, A. S., Bone marrow transplantation to irradiated dogs, 18: 33337
MALFAIT, L., Descendants of rats irradiated at a young age, 18: 33312
MALHOTRA, O. P., Hemorrhagic diathesis in rats fed irradiated beef, 18: 33992
MALINARIC, P., High-temperature nuclear particle detector, 18: 33918
MALINOWSKA, Teresa, Radiation effects on biosynthesis of heme, 18: 33400
MALLETT, J. F., Exchange parameters in Fe–Ni alloys, 18: 34187
MALMBERG, J. H., Collisionless damping of electrostatic plasma waves, 18: 35016
MAL'TSEVA, N. S., Reaction (p,pn$^+$) on In-115, 18: 34946
MALVICINI, A., Portable plant for decontamination of buildings and equipment, 18: 33800 (EUR-1821.f)
MALY, L., Decay of Re-186, 18: 34805
MALYKHIN, V. M., Absorbed dose from prolonged intake of Ra-226, 18: 33821
MANG, H.-J., Nuclear structure calculations for deformed nuclei, 18: 34781 (UCRL-11376)
MANI, H. S., W-meson decays in unitary symmetry, 18: 34565
MANN, E. R., Negative reactivity measurement by neutron fluctuation analysis, 18: 35074 (TID-7679(p.171-81))
MANN, Harry M., Radiation damage effects in Li-drifted Si detectors, 18: 33913
MANN, Harry M., Transient response of semiconductor detectors, 18: 33919
MARADUDIN, A. A., Inelastic scattering of neutrons by anharmonic crystals, 18: 34748
MARADUDIN, A. A., Scattering function $S(k,\omega)$ for inelastic scattering of neutrons, 18: 34460
MARBLE, Frank E., One-dimensional dynamics of gas-particle mixtures, 18: 33749
MARCOTTE, Ralph P., Experimental gas cooled reactor safety system analysis, 18: 35164 (TID-20891)
MARCUS, Y., Chemistry of Np(III), Pu(III), and Am(III) in halide solutions, 18: 33526 (IA-924)
MARCUSIU, E. C., Strontium exchange of soils from Alaska, 18: 33777
MARECEK, Josef, Determination of Cu, Hg, and Ag in pure U compounds, 18: 33509
MARIANESCHI, E., Steels for reactor pressure vessels, 18: 34097
MARIN, G., Frequency of sister chromatid exchanges following x rays, 18: 33329
MARION, Fernand, Equilibrium U_4O_9–U_3O_8, 18: 33546
MARKHAM, J. J., Optical absorption of the F and K bands in RbCl, 18: 34306
MARKHAM, Jordan J., Prog. rpt. on magnetic properties of insulators, 2/16–5/15/64, 18: 35243 (IITRI-1184-13)
MARKOV, B. N., Formation of fissioning isomer in capture of neutrons by Am, 18: 34759 (JINR-D-1693)
MARKOVA, N. F., Angular distribution of products of multinucleon transfer reactions, 18: 34763 (JINR-P-1675)
MARLOTTE, G. L., Heat transfer study for arc-jet engines, 18: 33752
MARQUEZ, L., Reaction in two states $^6Li(^6Li,\alpha)^8Be^*$, $^8Be^* = 2\alpha$, 18: 34819
MARSICO, B., Thermal parameters and neutron spectra in organic moderators, 18: 34734
MARTELL, E. A., Radioactive fallout from cratering shots, 18: 33775
MARTELLI, G., Production of He-3 from deuteron interactions, 18: 34544
MARTEN, W. F., Thermal testing of SNAP-10A prototype system (PSM-3), 18: 35200 (NAA-SR-9280)
MARTENS, John H., Catalog of nuclear reactor concepts. Pt. I, Sec. I, 18: 35119 (ANL-6892)
MARTIN, A., Unitarity bounds of the scattering amplitude and the diffraction peak, 18: 34560
MARTIN, Alfred John, Production of Be having increased ductility at high temperatures, 18: 34070
MARTIN, Arthur W., Approximate bootstrap technique, 18: 34562
MARTIN, F. W., Junction counters produced by ion implantation doping, 18: 33921
MARTIN, Francis H., Preparation and melting point of XeF_4, 18: 33593
MARTIN, J., Activation analysis of high-purity Si, 18: 33502
MARTIN, J. L., Basal slip kink bands in polycrystalline Zr, 18: 34193
MARTIN, K. B., Low-temperature seals for plastic windows, 18: 34685
MARTIN, W. H., Half life for $Fe^{54}(n,p)Mn^{54}$ reaction, 18: 34885
MARTINEZ, J. S., Direct cycle radioisotope-heated rocket engine, 18: 34003
MARTTILA, O. J., Versatile coincidence spectrometer, 18: 33950
MARTYNOV, Yu. S., Mean energy of Pr-142 β spectra, 18: 34954
MARZOLF, John G., Standard reference wave lengths for x-ray spectroscopy, 18: 34341
MASON, E. A., Diffusion cross sections for N^+–N and O^+–O collisions, 18: 34418
MASON, E. A., Startup of solid core nuclear rockets, 18: 35213
MASON, Edward A., Pyrolysis and radiolysis in degradation of terphenyls, 18: 33619 (MITNE-48)
MASPERONI, A., Influence of rate cooling from γ phase on U alloys, 18: 34127 (RT/MET(64)-2)
MASSOT, J. N., Calculation of (n,α) angular distributions, 18: 34876
MASSOT, Jean-Noel, Reactions (n,α) by direct interaction model, 18: 34769 (NP-14085)

MASUDA, Hachiko, N/D formalism for scattering amplitudes, 18: 34605
MATHAMS, R. F., Calculation of Te and I fission-product activities, 18: 35228
MATHAUSER, Eldon E., Refractory metals for thermal-protection systems, 18: 34062
MATHESON, Robert M., Recent photomultiplier developments at RCA, 18: 33903
MATLAN, L. G., Radiation changes in cranial bones, 18: 33338
MATSEN, F. A., Electronic properties of Li hydride, 18: 34444
MATSON, L. K., Electrical properties of rare earth compounds and alloys, 18: 34158
MATSUDA, Kazuhisa, Numerical differential cross sections of $Ca^{40}(p,d)Ca^{39}$ at 55 Mev, 18: 34757 (INSJ-72)
MATSUDA, Masanori, f^0-Meson and p-p scattering, 18: 34610
MATSUNAGA, Fumiko, Adolescents exposed *in utero* to atomic bomb. I., 18: 33391
MATSUYAMA, A., Radiation sensitivity of bacterial spores, 18: 33996
MATSUYAMA, A., Radiation sensitivity of vegetative bacteria, 18: 33326
MATTIS, D. C., Two-dimensional Ising model, 18: 34356
MATTUCK, R. D., Lifetime of quasi particles in Fermi system, 18: 34549
MATUMOTO, Ken-iti, Parity doublet hypothesis of strange particles, 18: 34612
MATUSEVICH, E. S., Spatial distribution of dose of scattered γ radiation, 18: 33810
MATYASOVA, J., Liberation of desoxy-ribo-poly-nucleotides from irradiated tissues, 18: 33308
MATYUSHENKO, N. N., Reactions of $MoSi_2$ with Be, 18: 34149
Mau, Nicole Vinh
see Vinh Mau, Nicole
MAUCHLINE, John, Accumulation of radionuclides by thornback ray, 18: 33248
MAUGIS, D., Cesium plasma capillary emitter as source of Cs ions, 18: 34502
MAY, R. M., Damping of transverse plasma oscillations at ion cyclotron resonance, 18: 34974 (NP-14153)
MAY, R. M., Formation of neutral atoms by charge-exchange, 18: 34434
MAY, R. M., Matrix elements for charge-exchange processes, 18: 34432
MAYCOCK, G., Measurements of Ra in Ra luminizers, 18: 33262
MAYEDA, T., Paleotemperature analysis of fossil shells of marine mollusks, 18: 33784
MAYFIELD, Hannah B., Report number series, 18: 35251 (TID-85(3rd Rev.))
MAYNEORD, W. V., Assessment of α radioactivity in human tissues, 18: 33819
MAYO, Ralph E., Signal enhancement of the Varian A-60 NMR spectrometer, 18: 33866
MAZAKI, Hiromasa, Positron emission in decay of Eu-152, 18: 34820
MAZANOWSKA, Anna, Radiation effects on biosynthesis of heme, 18: 33400
MAZITOV, B. S., Gamma exposure meter, 18: 33854 (AEC-tr-6399(p.221-6))
MAZITOV, R. K., Magnetic relaxation of Li-7 nuclei in aqueous solutions paramagnetic salts, 18: 33601
MC BRIDE, David A., Neutron flux distributions in water system with internal cavity, 18: 34731 (NASA-CR-54110)
MC BURNEY, C. B. M., Paleotemperature analysis of fossil shells of marine mollusks, 18: 33784
MC CARDELL, R. K., SPERT I destructive test program on Al, plate-type, water-moderated reactor, 18: 35220 (IDO-16883)
MC CARTHY, Renee, Personnel dosimetry practice, 18: 33807 (RISÖ-78)
MC CLURE, J. W., Neutron spectra from the (p,n) reaction, 18: 34859
MC COLLUM, W. A., Prog. rpt. on effects of radiation on Ni–Cd battery electrodes, final, 6–12/63, 18: 34213 (AI-64-11)
MC CONNELEE, J. E., Thermal stress evaluation of ceramic fuel elements, 18: 34166
MC CREA, J. M., Mass spectrometer as an effusiometer, 18: 33867
MC CUNE, James E., Master equation for plasmas, 18: 35046
MC DANIEL, E. W., Prog. rpt. on ionization of alkali ions by electron impact, 3–5/64, 18: 34406 (TID-20877)
MC DANIEL, J. D., Satellite instrumentation for measurement of auroral phenomenon, 18: 33935
MC DONALD, F. B., Intensity and modulation of low-rigidity cosmic rays, 18: 34477
MC DONALD, F. B., Primary cosmic radiation near solar minimum, 18: 34481
MC DONALD, Jose, Jr., Prog. rpt. on Elk River reactor pressure vessel, 4–5/64, 18: 35154 (SWRI-1228-28)
MC DONALD, R. S., New O infrared bands in annealed irradiated Si, 18: 34239
MC ELROY, D. L., High-temperature high-vacuum thermocouple drift tests, 18: 33833 (ORNL-TM-883)
MC EWEN, Lawrence H., Safety in reactor design, 18: 35121
MC FARLAND, B. L., Nerva thermal and fluid flow analysis, 18: 33751
MC FEE, A. F., Effects of Ce-144 administered to pregnant rats, 18: 33352
MC GEE, Ian J., K-meson decays, 18: 34506 (BNL-8094)
MC INERNEY, J. J., Monoenergetic neutron diffusion length, 18: 34742
MC INTURFF, A. D., Determination of the Σ^+ magnetic moment, 18: 34591
MC INTYRE, R. J., Stabilization of Li-drifted radiation detectors, 18: 33922
MC KANNAN, E. C., Effects of radiation on engineering materials, 18: 34247
MC KEE, Robert J., Jr., Ground state of a many-fermion system. II., 18: 34559
MC KENZIE, D. E., Prog. rpt. on effects of radiation on Ni–Cd battery electrodes, final, 6–12/63, 18: 34213 (AI-64-11)
MC KINNEY, Russell A., Internal pulse amplification in Si p-n junction, 18: 33959
MC LAIN, Stuart, Commercial power reactors cooled with gas or light water, 18: 35160 (TID-8540(p.1-69))
MC LAUGHLIN, Ralph, Absorption spectrum of At, 18: 33578
MC MILLAN, Robert C., ESR of K colloids in KN_3, 18: 33647
MC MULLAN, John T., Magnetic susceptibility of 2 $^3S_1$ state of He, 18: 34438
MC NEILL, Dale A., Coupling of waves at plasma-neutral gas interface, 18: 35004
MC NIFF, E. J., Jr., Prog. rpt. on superconductive effects in films, 7/15–10/15/63, 18: 33824 (AD-428788)
MC PHERSON, R., Decay of Ne-17 and delayed proton emission, 18: 34899
MC QUARRIE, Donald A., Classical theory of fluids for the square-well potential, 18: 34300
MC QUILLAN, A. D., Characteristics of the early transition metals, 18: 34202
MC TRAGGART, F. K., Zirconium difluoride, 18: 33544
MEATH, William J., Differential equations of Brillouin-Wigner perturbation theory, 18: 34024
MEECHAM, William C., Satellite signal fluctuation caused by ionospheric irregularity, 18: 34253
MEERS, J. T., Preparation of graphites for irradiation, 18: 34041 (HW-80752)
MEJDAHL, V., Personnel dosimetry practice, 18: 33807 (RISÖ-78)
MELCHING, H.-J., Radioprotection efficiency of histamine in mice, 18: 33414
MELTON, C. E., Secondary ions produced by ion-neutral reactions, 18: 33569
MELTZ, Gerald, Antenna pattern distortion due to plasma layer, 18: 34968 (AFCRL-64-18)
MEMELOVA, L. Ya., Spectrometric determination of microquantities of B in materials, 18: 33479
MENDELSSOHN, K., Vorticity in liquid He-II, 18: 34691
MENICHELLA, E. Saetta, Analysis of (n,α) nuclear reactions, 18: 34810
MENLOVE, H. O., Fast-neutron capture and inelastic-scattering cross sections of In-113 and In-115, 18: 34962
MERCEREAU, J. E., Fluxoid conservation by superconducting thin film rings, 18: 34698
MERCEREAU, J. E., Quantum interference effects in superconductors, 18: 34696
MERCURI, R. A., High-temperature protective coatings for graphite, 18: 34043 (ML-TDR-64-173(Pt.I))
MERELLI, A., Void fraction in experimental loops, 18: 33739 (RT/ING(64)-5)
MESCHAN, I., Incorporation of unbound iodide-131 into non-radioactive hippuran molecule, 18: 33646
MESHCHERYAKOV, V. A., Relativistic corrections to s and p waves of π-N scattering, 18: 34507 (JINR-E-1686)
MESHKOV, S., "U-spin equalities" and octet symmetry breaking, 18: 34586
MESSIER, J., Thick junctions made with nuclear-compensated Si, 18: 33920
METCALFE, A. G., Joining of refractory metals, 18: 34108
METCHNIK, V., Efficiencies of counters for x radiation, 18: 33896
METZGER, P. H., Photoionization and absorption cross sections of H_2 and D_2, 18: 34421
MEYER, F., Electron impact study of methyl phenyl ethers, 18: 33627
MEYER, George E., Production, properties and working of hot-pressed Be billets, 18: 34113
MEYER, Horst, NMR in solid H_2 and D_2 under high pressures, 18: 34260 (AD-601933)
MEYER, R. A., Impact of graphite fuel development on steam generation, 18: 35176
MEYER, Raymond A., Determination of C in Na, 18: 33477
MEYER, William, Prog. rpt. on steam separation technology, 4–6/64, 18: 33693 (ACNP-64026)
MEYEROTT, Roland E., Auroral measurements, 18: 34672
MEZHOV-DEGLIN, L. P., Heat conductivity of solid He-4, 18: 34718
MICEK, S., Elastic scattering of 24.7-Mev α particles, 18: 34902
MICHAEL, A. B., Development of refractory metal alloys, 18: 34069

MICHALOWICZ, A., Kinematics of nuclear reactions, 18: 34956
MICKELSEN, William R., Large modules and arrays of electrostatic thrustors, 18: 33704
MICKEY, D. D., Radiation tolerance of TIMM, 18: 33869
MIHALCZO, John T., Prompt-neutron lifetime in critical enriched-U cylinders and annuli, 18: 34496
MIIDA, J., Noise analysis of reactor systems, 18: 35073 (TID-7679 (p.155-69))
MIKHAILOV, A. I., Relativistic atomic photoeffect, 18: 34847
MIKHAILOVICH, S. M., Lagochylus in Po-210 radiation injuries, 18: 33412
MIKHAILOVSKII, V. V., Increasing efficiency of transmission of radioactive-emission parameters, 18: 33853 (AEC-tr-6399(p.207-20))
MILLER, A. D., Thermal conductivity of UC, 18: 34120 (CNLM-5621)
MILLER, A. D., Thermal decomposition of UC, 18: 33523 (CNLM-5619)
MILLER, A. D., Thermal decomposition of UN, 18: 33524 (CNLM-5620)
MILLER, Donald S., Origin of the Colorado Plateau U ores, 18: 33796
MILLER, E. H., Modern nuclear turbine design, 18: 33753
MILLER, E. K., Prog. rpt. on microwave plasma components study, 18: 34977 (RADC-TDR-64-94)
MILLER, G. L., High-speed analog pulse divider, 18: 33929
MILLER, J. F., Electrical properties of rare earth compounds and alloys, 18: 34158
MILLER, Julian Malcolm, Nuclear and radiochemistry, 18: 33455
MILLER, R. W., SPERT I destructive test program on Al, plate-type, water-moderated reactor, 18: 35220 (IDO-16883)
MILLER, Robert W., Cancer mortality among underground metal miners, 18: 33813
MILLER, S. L., Isotopic and cosmic chemistry, 18: 33456
MILLER, T. G., Measurement of D(d,n)He^3 neutron polarization, 18: 34963
MILLHOLLEN, M. K., Multicomponent tubular UO_2 fuel element irradiations, 18: 35129 (HW-80291)
MILNE, J. D., Insulation for 11-kv 280-kg pulsed magnet, 18: 33717
MILTON, J. C. D., Monte Carlo calculation of neutron production in heavy element targets by protons in range 0.3 to 1 Bev, 18: 34961
MINCHEVA, L. D., Elastic scattering of 6.2-Bev protons on deuterons, 18: 34616
MING, Mei-pen, Preparation of Mo single crystals, 18: 34061 (FTD-TT-64-350)
MINTON, G. H., Calculation of resonance integrals, 18: 34744
MIRALDI, Floro, Neutron flux distributions in water system with internal cavity, 18: 34731 (NASA-CR-54110)
MIROYIANNIS, S. D., Radiation effects on Nissl granules in rat spinal cord neurons, 18: 33349
MISAKI, Akeo, Lateral deviation for electrons in cascade shower, 18: 34487
MISKEL, J., K Auger group intensities in Cl-37, 18: 34789
MISRA, Sushil, Low-temperature dynamic nuclear polarization, 18: 34717
MISSO, C. E. F., New developments in radiation detectors, 18: 33904
MITANI, Hiroshi, Prompt neutron lifetime in a reflected system, 18: 35116
MITSIS, George J., Transport equation in plane geometry, 18: 34743
MITTLEMAN, Marvin H., Coupled equations for rearrangement collisions, 18: 34643
MITYUKOV, N. G., Radioactive liquid analyzer, 18: 33473 (AEC-tr-6399 (p.115-23))
MIYAMOTO, Yoneji, Nonleptonic hyperon decays, 18: 34609
MIYASAKA, Yasuhiko, The void and hole effect in D_2O-moderated reactor, 18: 35083
MOBLEY, R. M., Fine-structure constant from muonium hfs interval, 18: 34921
MOEHL, D., Resonator in FFAG synchrotron vacuum chamber, 18: 34371 (NP-13986)
MOH, Carl C., Radiosensitivity of tropical plant species, 18: 33389
MOHLING, Franz, Degenerate Bose system. I., 18: 34337
MOHLING, Franz, Degenerate Bose system. II., 18: 34338
MOHLING, Franz, Degenerate Bose system. III., 18: 34339
MOLBERT, Michel, Criticality experiments with annular cylinders containing Pu solutions, 18: 34494 (CEA-R-2495)
MOLINARI, V. G., Thermal parameters and neutron spectra in organic moderators, 18: 34734
MOLITOR, J. H., Design and performance of ion engine systems, 18: 33699
MOLLENAUER, James F., Display oriented data simulation and analysis, 18: 34366 (BNL-8166)
MOLLICA, Guido, Adjustable fuel and reflector element lattice, 18: 35087
MOLLOY, C. T., Prog. rpt. on kinetic studies of heterogeneous water reactors, 1–3/64, 18: 35067 (STL-372-3)
MOLT, E. L., Determination of radioactive Sr in H_2O, 18: 33484
MONG, Bernard A., Neutronic reactor, 18: 35233
MONGON, Alain, Instrumentation in nuclear fuel reprocessing plant, 18: 33856
MONTAGUE, J. H., Reaction $Ne^{22}(d,n)Na^{23}$, 18: 34832
MONTES DE OCA, Rodolfo A., Nuclear powered surface-effect ships design problems, 18: 35215
MONTNER, J., Radiation-resistant magnetic amplifier controls, 18: 33825 (AD-435095)
MOORADIAN, A. J., Future targets for Canadian power reactors, 18: 35173
MOORE, Arthur, Deuterium content of phenocrysts, 18: 33788
MOORE, C. Fred, Nuclear reaction $Y^{89}(d,p)Y^{90}$, 18: 34834
MOORE, L. C., Nerva thermal and fluid flow analysis, 18: 33751
MOORE, M. S., Fission cross section of Pu-241, 18: 34914
MOORE, R. A., Heat transfer study for arc-jet engines, 18: 33752
MOORE, R. E., Effect of fast-neutron irradiation on BeO compacts, 18: 34224
MOORE, S. O., Calculations of inelastic scattering of neutrons by heavy nuclei, 18: 34910
MORAVEC, J., Radiation effects on ketone extraction. II., 18: 33621 (UJV-977/64)
MORET, R., Application of γ spectrometry to analysis of radioisotope traces in water, 18: 33485
MORET-BAILLY, Francoise, Singular neutrino and electron fields, 18: 34527
MORGAN, A., Determination of Pu in urine, 18: 33677
MORGAN, A., Role of fecal analysis in a bio-assay program, 18: 33266
MORI, K., Properties of very high-energy inelastic processes from measurements on recoil baryon, 18: 34632
MORIARTY, J. L., Role of coprecipitation in alloy partition during crystallization, 18: 34192
MORIN, M., Data processing at EDF-3 Chinon Plant, 18: 34017
MORIYAMA, Hideo, Studies on X agent. XXXIV., 18: 33671
MORIYAMA, Hideo, Studies on X agent. XXXV., 18: 33672
MORIYAMA, Hideo, Studies on X agent. XXXVI., 18: 33673
MORIYAMA, Jyoichiro, Extraction and separation of Ta and Nb, 18: 33688
MORLEVAT, Jean-Pierre, Uranium oxycarbide–dioxide eutectic, 18: 34144
MORONI, J. P., High-activity dusts isolated in fallout, 18: 33770 (SCPRI(S)-99)
MORONI, J. P., Internal contamination from radioactive fallout, 18: 33429
MOROZUMI, Shotaro, Structure in a Mg–Zr alloy, 18: 34182
MORRIS, A. C., Jr., High-level whole-body counter, 18: 33937
MORRIS, R. G., Specific heat measurements of EuSe and EuTe, 18: 34695
MORRISON, R., Ionization produced in gas by beam of relativistic electrons, 18: 34270 (LAL-1093)
MORROW, Frederick, Production of Be having increased ductility at high temperatures, 18: 34070
MORSE, David C., Fuel element, 18: 35136
MORSELL, A. L., Proton energy-loss distributions from thin C films, 18: 34918
MORTENSEN, J. L., Strontium exchange of soils from Alaska, 18: 33777
MORTON, J. R., ESR spectra of oriented radicals, 18: 33630
MORTON, P. H., Systems Nb–Zr–C and Nb–Zr–O, 18: 34211
MOSCHINI, E., Somatic mutations in carnations induced by γ rays, 18: 33302
MOSER, C. M., Hyperfine splitting of ^1D levels of He-3, 18: 34903
MOSKALENKO, I. P., DNase activity of tissues at different stages of radiation damage, 18: 33361
MOSKALEV, V. I., Catalysis of $d + d \rightarrow He^3 + n$ fusion reaction by μ^-, 18: 34617
MOULTON, R. J., Heater for graphite channel oxidation experiment, 18: 33711 (AERE-M-1373)
MOURSUND, A. L., Scattering of K by HCl and HI in crossed molecular beams, 18: 33560
MOZRZYMAS, J., Baryon-charge and hyper-charge, 18: 34647
MRAVA, Gene L., Silent mercury rankine cycle power system, 18: 33721
MUEHRCKE, Robert C., Radiation nephritis, 18: 33288
MUELLER, R. E., Loading to criticality of Fermi reactor, 18: 35139 (APDA-NTS-1)
MUHEIM, J., Specific heat measurements of EuSe and EuTe, 18: 34695
MUKHERJEE, Ila, Interpretation of $Pb^{206}(d,p)Pb^{207}$ reactions, 18: 34871
MUKHERJEE, Paresh, Interpretation of $Pb^{206}(d,p)Pb^{207}$ reactions, 18: 34871
MUKHERJEE, S. K., Radioactive decay of Lu-178, 18: 34843
MUKHIN, A. I., Transition of μ^- mesons from proton to C, 18: 34947
MULFORD, R. N. R., Vapor pressure of Np, 18: 33570
MULHALL, Walther J., Interaction of four like nucleons in same shell, 18: 34863
MULLAN, S., Nuclear needle for use in neurosurgery, 18: 33436
MULLER, K., Development status of low-power arc-jet engines, 18: 33705
MUNIR, Basharat A., Automatic measuring and gap counting machine for bubble chamber pictures, 18: 33971
MUNSON, J. H., Scanning and measuring projector, 18: 33957
MURASE, Hirokazu, Neutron distribution in hydrogenous moderators, 18: 34736
MURDEN, Peter, Improvements in temperature-indicating devices, 18: 33872
MURGATROYD, W., Stochastic models for fission reactors, 18: 35070

(TID-7679(p.29-59))
MURRAY, Joseph J., Production of $\Xi K(n)\pi$, $\Lambda K\bar{K}(n)\pi$, and $\Sigma K\bar{K}$ final states, 18: 34514 (UCRL-11430)
MURTHY, V. Rama, Heavy elements in meteorites, 18: 34400
MUSAEV, U. N., IR spectra of acrylonitrile–α-methylfuran copolymers, 18: 33670
MUSYCK, E., Instrument for radiochromatogram reading, 18: 33490
MUTH, H., Clinical findings of persons with Ra burdens, 18: 33424
MUTH, H., Thoron in breath of Thorotrast patients, 18: 33425
MUTH, H., Thorotrast deposits in the kidney, 18: 33426
MUXART, Roland, Iodine-131 formed in neutron irradiation of Te compounds, 18: 33661
MYERS, D. K., Potassium levels in regenerating rat liver, 18: 33301
MYERS, G., Dynamic studies with γ scintillation camera, 18: 34403
MYERS, J. R., Investigation of the $PbMoO_4$–$Bi_2(MoO_4)_3$ phase diagram, 18: 34195
MYERS, W. P. Laird, Prog. rpt. on kinetic state of Ca in bone lesions, 6/63–5/64, 18: 33233 (NYO-910-9)

N

NAJEAN, Y., Digestive absorption of Fe using radioactive indicator, 18: 33440
NAJEAN, Y., Study of circulation by an isotopic technique, 18: 33441
NAKAI, Yasushi, The void and hole effect in D_2O-moderated reactor, 18: 35083
NAKAJIMA, Tetsuo, Change of Curie temperature with pressure for Gd, 18: 34173
NAKAJIMA, Yutaka, Numerical differential cross sections of $Ca^{44}(p,d)Ca^{39}$ at 55 Mev, 18: 34757 (INSJ-72)
NAKAMOTO, T., Enzymatic synthesis of RNA. I., 18: 33243
NAKAMURA, Tomoo, Pulsed neutron experiment, 18: 34738
NAKANO, Takano, Radiation damage of carrier life time in Si, 18: 34228
NAKAYAMA, Takashi, Self-shielding factor of resonance foils, 18: 34737
NAKAYAMA, Yasuyuki, Positron emission in decay of Eu-152, 18: 34820
NAMBU, Yoichiro, Mass and coupling constant formulas in broken symmetry schemes, 18: 34589
NAQVI, J. H., Separable non-local nuclear potential for singlet states, 18: 34546
NARCHAL, Mohan Lal, Low-temperature dynamic nuclear polarization, 18: 34717
NARTEN, Alfred, Thermodynamic effects of mixing H_2O and D_2O, 18: 33567
NARUKI, Kaoru, Vibratory compaction of UO_2. I., 18: 34096
NASH, G. F., Excitations of mass-40 nuclei, 18: 34897
NASYROV, F., Ionization along track of U-235 and Cm-244 fission fragments, 18: 33895
NATH, A., Coherent scattering cross sections of γ rays, 18: 35053
NATH, L. M., Renormalizable EM interactions of charged vector mesons, 18: 34545
NATTER, Bernd, Flow turning of refractory metals, 18: 34109
NAUMKIN, O. P., Anisotropic properties of Sc monocrystals, 18: 34147
NEAL, L. G., Prog. rpt. on kinetic studies of heterogeneous water reactors, 1–3/64, 18: 35067 (STL-372-3)
NEARING, J. C., W-meson decays in unitary symmetry, 18: 34565
NEELAKANTAN, K. A., Modulation of low-energy galactic cosmic-ray H and He, 18: 34482
NEEPER, D. A., Thermal resistance at In–sapphire boundaries, 18: 34699
NEFEDOV, Yu. G., Biological effects and RBE of high-energy protons, 18: 33286 (UCRL-Trans-1068)
NEFKENS, B. M. K., Search for CP nonconservation in K_2^0 decays, 18: 34590
NEIDIGH, R. V., Observation of burnout in steady-state plasma, 18: 35014
NELIPA, N. F., Dispersion relations and KΛ photoproduction on a proton, 18: 34536
NELKIN, Mark, Time-dependent density correlations in fluids, 18: 34347
NELSON, C. T., Nondestructive determination of U-235 content of SNAP fuel rods. II., 18: 34044 (NAA-SR-9600)
NELSON, Donn K., Behavior of SNAP-10A during orbital reentry, 18: 35212
NELSON, George W., Neutron flux distributions in water system with internal cavity, 18: 34731 (NASA-CR-54110)
NELTRUP, H., Heavy-water lattice calculations, 18: 35112 (RISÖ-81)
NEMEC, J., Polarization measurements with protons scattered on C, 18: 34809
NEMETS, O. F., Elastic scattering of deuterons by Sr and Sn isotopes, 18: 34942
NEMETS, O. F., Inelastic scattering of deuterons by Sn even isotopes, 18: 34941
NEMOTO, Denzire, The void and hole effect in D_2O-moderated reactor, 18: 35083
NEMY, A. S., Primary working of refractory metals, 18: 34104
NENCI, G. G., Hemolysis by ionizing radiation, 18: 33345
NESTEROV, A. F., Reaction diffusion in metal–complex gas systems. VII., 18: 34146
NESTEROVA, N. M., Composition of primary cosmic radiation, 18: 34489
NEUDATCHIN, V. G., Nucleon cluster reduced widths, 18: 34891
NEUFELD, Jacob, Interaction of a plasma with a "helical" electron beam, 18: 35011
NEUSEN, Kenneth F., Prog. rpt. on vapor volume fraction and slip velocity, 4–6/64, 18: 33729 (ACNP-64027)
NEWMAN, David S., Equation of state for a gas, 18: 34655
NEWMAN, J. B., Electronic structure and spectral behavior of uranyl ion, 18: 33520 (AD-436582)
NEWTON, D., Inelastic scattering of 147-Mev protons from C-12, 18: 34816
NG, Soon, Fluorine-19 spin-spin coupling constants. I and II., 18: 33532 (UCRL-11395)
NGUYEN VAN DONG, Effect of fast neutrons on semiconductors, 18: 34237
NICHOLSON, E. L., Processing graphite reactor fuels, 18: 33687
NICKEL, John C., Experimental study of plasma wave resonances in hot non-uniform plasma column, 18: 34976 (NP-14195)
NICOL-SMITH, A. J., Mechanical properties of refractory metals, 18: 34206
NICULA, A., Electron spin resonance of Mn(II) ion in zeolites, 18: 34268 (IFA-IS-27)
NIEBUHR, W. J., X-ray spectrographic analysis for trace quantities of Ta in Nb, 18: 33458 (BM-RI-6483)
NIELSEN, H. L., Decay of 23.5-min U-239, 18: 34850
NIELSEN, H. L., K-forbidden β decay of Tb-160, 18: 34844
NIEMELAE, Lasse, Beta energies of Pr-143, S-35, and Pm-147, 18: 34785
NIEWODNICZANSKI, H., Elastic scattering of 24.7-Mev α particles, 18: 34902
NIGHTINGALE, R. E., Dimensional changes in large graphite bars, 18: 34231
NIHLGARD, Bengt, Inorganic ion exchangers. I., 18: 33535
NIKIFOROV, Igor Ia., X-ray Ly_4 emission band of 48 Cd, 18: 34411
NIKIFORUK, P. N., Photoelectric scanning system for auroral height measurements, 18: 34674
NIKITIN, M. D., Radiation safety in flights of Soviet cosmonauts, 18: 33815
NIKITIN, V. A., Elastic p-p scattering at 8.3 Bev, 18: 34508 (JINR-P-1674)
NIKITIN, Yu. P., Regge poles and amplitude production of vector mesons, 18: 34622
NIKOLAEV, A. I., Intensity and relationship between nucleic acid, protein and lipid synthesis in spleen of irradiated rats, 18: 33382
NIKOL'SKII, S. I., Composition of primary cosmic radiation, 18: 34489
NILES, Franklin E., Atomic emission of the He afterglow, 18: 34419
NILES, Franklin E., Intensity in a He afterglow, 18: 34310
NILSSON, A., Independence of the velocity of light of the motion of the light source, 18: 34294
NILSSON, I., Exposure following ingestion of H_2O containing Rn-222, 18: 33820
NILSSON, Lennart, Inorganic ion exchangers. I., 18: 33535
NILSSON, Sven Goesta, Fluctuations in particle number in pairing wave functions, 18: 34839
NIMIDOFF, D. A., Biological effects and RBE of high-energy protons, 18: 33286 (UCRL-Trans-1068)
NIMS, J. B., Loading to criticality of Fermi reactor, 18: 35139 (APDA-NTS-1)
NISHIDA, Minoru, Neutrino pair emission from excited nuclei, 18: 34932
NISHIMURA, Senji, Extraction and separation of Ta and Nb, 18: 33688
NISHIO, Gunji, Isotopic exchange reaction between U(IV) and U(VI) ions. I., 18: 33577
NISSIM-SABAT, C., K_{α} μ-mesic x rays of Ca-40 and Ca-44, 18: 34900
NIU, Keishiro, Structure of plane shock wave in plasma, 18: 34998
NIX, James Rayford, Liquid-drop theory of nuclear fission, 18: 34778 (UCRL-11338)
NOBLE, G. A., Optical absorption of the F and K bands in RbCl, 18: 34306
NOGGLE, Joseph H., Spin decoupler for NMR, 18: 33864
NOMURA, Tsutomu, Some aspects of zero power reactor transfer function, 18: 35115
NONAKA, Itaru, Numerical differential cross sections of $Ca^{44}(p,d)Ca^{39}$ at 55 Mev, 18: 34757 (INSJ-72)
NORDBY, H., Preparing α- and β-spectroscopy sources, 18: 33654
NORDLING, C., Double-focusing β spectrometer (50 cm), 18: 33947
NORELAND, Erik, L-absorption spectra and the L-emission bands of 46 Pd–52 Te, 18: 34412
NORELAND, Erik, X-ray L-emission bands of 46 Pd–52 Te, 18: 34410
NORELAND, Erik, X-ray Ly_4 emission band of 48 Cd, 18: 34411
NORETS, T. A., Effectiveness of DTPA in contamination by lethal doses of Ce-144, 18: 33417
NORGATE, G., Stabilization of Li-drifted radiation detectors, 18: 33922
NORRIS, J. E., Nuclear test detection spacecraft, 18: 33703

NORTHCOTT, L., Mechanical properties of refractory metals, 18: 34206
NORTON, Horace W., Hemorrhagic diathesis in rats fed irradiated beef, 18: 33992
NORTON, J. J., Ancient granite gneiss in Black Hills, 18: 33768
NOUZA, K., Disease of sublethally irradiated F_1 hybrids after administration of parental lymphoid cells, 18: 33320
NOVAK, J., Electron temperature in positive column of electric discharge, 18: 34299
NOVAK, L., Energy balance and radiation sensitivity in rats, 18: 33365
NOVAK, L., Resonance of F center in x-irradiated F^{18}-doped BeO, 18: 33657
NOVAKOVA, J., Exchange reactions of O-18 with oxidation catalysts. II., 18: 33545
NOVICKIS, Georgs, Heat exchangers for GCR, 18: 35150 (NYO-9789)
NOVIKOV, I. I., Heat transfer in conducting fluid at small Reynold's number, 18: 34359
NOVIKOV, V. T., Mean energy of Pr-142 β spectra, 18: 34954
NOVIKOVA, M. N., Bone marrow transplantation to irradiated dogs, 18: 33337
NOWER, T. M., Reaction $Al^{27}(d,\alpha)Mg^{25}$ at 1.5 to 2.6 Mev, 18: 34823
NOZAWA, Masao, Pulsed neutron experiment, 18: 34738
NOZIERES, P., Perturbation expansion for Bose liquid at zero temperature, 18: 34686
NUGENT, L. J., Ligand field spectra of some new laser chelates, 18: 33565
NYSTEN, K.-E., Lifetimes of $d_{3/2}$ hole states in Sc isotopes, 18: 34923

O

OAKES, R. J., Angular correlations in production processes, 18: 34569
OBERHAUSEN, E., Clinical findings of persons with Ra burdens, 18: 33424
OBERHAUSEN, E., Thoron in breath of Thorotrast patients, 18: 33425
OBERHAUSEN, E., Thorotrast deposits in the kidney, 18: 33426
O'BRIEN, Joseph F., Design and construction of new coaxial electrical discharge pin, 18: 33862
OBUCHOWSKA, Irena, Radiostrontium in soil and plants in Warsaw district, 18: 33778
OCHRYMOVIC, O., Effect of physostigmine on irradiated rats, 18: 33306
ODEH, Farouk M., Nonlocal theory of superconductivity, 18: 34692
ODELL, Allen, Hot H displacement reaction with isobutane, 18: 33640
ODIAN, George, Radiation crosslinking of polyisobutylene, 18: 33652
O'DONNELL, W. J., Fatigue design basis for Zy components, 18: 34233
OEHME, R., Commutation relations of weak currents, 18: 34657
OEHRN, Yngve, Penetration effects in ^2F series of CsI, 18: 33579
OELGAARD, P. L., Heavy-water lattice calculations, 18: 35112 (RISÖ-81)
OERTEL, Karl-Heinz, Radiation measuring apparatus, 18: 33975
OESTGAARD, Erland, Quasi-deuteron production by γ rays in O-16, 18: 34926
OFFNER, H. G., Determination of H in Nb, 18: 33538
OGANDZHANYAN, E. E., Effect of certain hormones on hemopoiesis and survival of irradiated mice, 18: 33416
OGASAWARA, Kohei, Plasma confinement device with reversed field. I., 18: 34993
OGAWA, S. Y., Irradiation performance of UO_2–cermet fuel, 18: 34086 (GEAP-4435)
OGAWA, Seiji, g Factor of H atoms trapped in phosphates, 18: 33645
OGAZA, S., Hfs interaction of Gd-155 nucleus, 18: 34898
OGDEN, H. R., Transition properties of wrought Ta and Nb, 18: 34196
OGDEN, J. W., Prog. rpt. on converter for nuclear thermionic energy source, final, 5/3–12/3/63, 18: 34497 (NP-12888(Vol.5))
OHIMA, Koichi, Strong blast waves in electrogasdynamics, 18: 34318
OHNUMA, Hajime, Fast neutron time-of-flight system, 18: 33944
OHTSUBO, Hisao, Interaction Λ-Λ with repulsive core, 18: 34607
OKADA, Minoru, Nuclides formed by neutron activation, 18: 33492
OKHRIMENKO, L. S., Reaction $\pi^- + Xe \rightarrow \pi^- + \pi^0 + Xe$ for 9-Bev/c primary π^- mesons, 18: 34949
OKUBO, S., Prediction of a $\pi\eta$ resonance, 18: 34572
OLEINIK, V. G., Investigation of oxidative destruction of polyamides. I., 18: 33668
OLESEN, P., Relation between self interaction and mutual interaction, 18: 34540
OLIVER, John, Improvements in nuclear reactors, 18: 35101
OLTE, Andrejs, Prog. rpt. on microwave plasma components study, 18: 34977 (RADC-TDR-64-94)
OMNES, Roland, Extension of three-body scattering amplitude to complex values of total angular momentum, 18: 34518 (UCRL-11546)
ONDREJCIN, Robert S., Determination of U isotopes in irradiated Th, 18: 33462 (DP-883)
ONEDA, S., ϕ-ω mixing angle, 18: 34574
O'NEIL, James R., Oxygen isotope geothermometry, 18: 33785
ONISHI, Hiroshi, Spectrophotometric determination of Ce with TTA, 18: 33540
ONO, Reiko, Extraction of Cm and Am by tri-n-octyl phosphine oxide, 18: 33686
ONO, Syu, Derivation of generalized Boltzmann equation, 18: 34315
OPARA-KUBINSKA, Zofia, Properties of 5-bromodeoxyuridine-labeled transforming DNA, 18: 33402
OPENSHAW, P. R., Oxidation of U–Al compounds. I., 18: 34077
ORAEVSKII, V. N., Instabilities of electron Langmuir oscillations of plasma in magnetic field, 18: 34989
O'RAIFEARTAIGH, L., Uniqueness of the harmonic oscillator commutation relation, 18: 34662
ORIOVA, L. V., Radioprotective properties of ACTH, 18: 33411
ORLOVA, Z. I., Trace elements in radiation dermatitis, 18: 33285 (JPRS-25502)
ORMAN, S., Influence of O on U–H_2O reaction. III., 18: 34072 (AWRE-O-40/64)
ORSAGE, R., Analysis of refractory metals, 18: 33516
OSAKABE, Tomiko, Solvent extraction in TBP–HNO, or -HCl systems, 18: 33685
OSBORNE, F. J. F., Plasma trapping within the magnetosphere, 18: 34984
OSBORNE, Thomas S., Seed radiosensitivity, 18: 33384
OSIPOV, K. A., Limiting values for activation of creep in Ti–Zr alloys, 18: 34152
OSTERRIED, Otto, Flame photometry determination of small Cs contents, 18: 33500
OSTROSKI, J., High-temperature nuclear particle detector, 18: 33918
O'SULLIVAN, W. J., Electric field gradient in metallic In, 18: 33585
OTOKOZAWA, Jun, N/D formalism for scattering amplitudes, 18: 34605
OTTO, H. L., Synthesis of labeled organic compounds, 18: 33631
OTTOWITZ, Peter J., Superconductive wire, 18: 34200
OTWAY, Harry, Large volume operational room inerting, 18: 33804 (LADC-6432)
OVAKIMOV, V. G., Central M-choline reactive systems of irradiated mice, 18: 33368
OVCHARENKO, E. Yo., Scintillation counters with light ducts, 18: 33850 (AEC-tr-6399(p.163-72))
OWEN, George E., Differential cross sections for reaction $B^{11}(d,p)B^{12}$, 18: 34909
OWEN, W. S., Substructure in refractory metals, 18: 34204
OZEKI, M., Colored multiscintigram system, 18: 33968

P

PACINI, L., Somatic mutations in carnations induced by γ rays, 18: 33302
PAI, Shih I., Survey of magnetofluid dynamics, 18: 34264 (ARL-63-175 (Pt.II))
PAIN, J., High stability multiparametric modular circuitry at Saclay's cyclotron, 18: 33936
PAIS, A., Implications of spin-unitary spin independence, 18: 34583
PAIZIEV, P., Radiation effects on cotton seeds, 18: 33333
PAJAS, Petr, Polarizability in nuclear physics, 18: 34526
PAL, B., Nuclear binding energies, 18: 34812
PAL, Yash, Propagation of cosmic rays through the atmosphere, 18: 34485
PALADI, M., Poisoning during isotopic exchange reaction between H and H_2O, 18: 33527 (IFA-28-IS)
PALINCHAK, S., Effect of space environment on materials, 18: 34235
PALIT, P., Calculated energies of 2p-1s μ-mesonic x rays, 18: 34435
PALME, R., Refractory metals, 18: 34178
PALMER, D. W., Detailed forms of yield curves from semi-thick Al targets, 18: 34917
PALOMARES DELGADO, F., Solvent-extraction applied to analysis of U. II., 18: 33680 (JEN-137-DQ/I-41)
PALOMARES DELGADO, F., Solvent-extraction applied to analysis of U. III., 18: 33681 (JEN-138-DQ/I-42)
PALOMARES DELGADO, F., Solvent extraction systems applied to U analysis. I., 18: 33679 (JEN-136-DQ/I-40)
PALOMARES DELGADO, F., Spectrophotometric determination of U, 18: 33463 (JEN-139-DQ/I-43)
Palomino, J. Vera
see Vera Palomino, J.
PANDE, Lalit Kumar, Dynamics of Ω^-, 18: 34568
PANDRES, Dave, Jr., Internal quantum numbers without internal coordinates, 18: 34625
PANDYA, S. P., Effective interactions in the nuclear shell model, 18: 34869
PANTUEV, V. S., Pulse amplitude analysis with photography, 18: 33893
PAPA, Robert J., Nonlinear interaction of EM wave with time-dependent plasma medium, 18: 34970 (AFCRL-64-250)
PARCHEVSKII, V. P., Liquid scintillation counter for measurement of β activity of preparations in layers, 18: 33659
PARIN, V. V., Radiation safety in flights of Soviet cosmonauts, 18: 33815
PARK, J. J. H., Gamma transitions in Np-237, 18: 34802

PARKER, Jerald V., Theory of plasma wave resonances in hot nonuniform plasma, 18: 34975 (NP-14194)
PARKER, K., Neutron cross sections of U-236 in range 1 kev to 15 Mev, 18: 34750 (AWRE-O-30/64)
PARKER, R. C., Large volume operational room inerting, 18: 33804 (LADC-6432)
PARR, Robert M., Rigorous least-squares analysis of complex γ spectra, 18: 33926
PASHOS, T. J., Uranium dioxide thermal conductivity from irradiations with central melting, 18: 34215 (GEAP-4624)
PASTERNAK, R. A., Prog. rpt. on sorption of gases on metal surfaces in vacuum, 2/15–5/15/64, 18: 34282 (TID-20837)
PATASHINSKII, A. Z., Phase transition in superconductors, 18: 34719
PATELL, R., Neutron binding energies in heavy nuclei, 18: 34966
PATHAK, K. M., Disintegration of emulsion nuclei, 18: 34811
PATI, J. C., ϕ-ω mixing angle, 18: 34574
PATIL, Shamshchandra H., Analysis of s-wave $\pi\pi$ interaction, 18: 34595
PATROVSKII, Venceslav, Analytical chemistry of Nb and Ta, 18: 33482
PATTERSON, Clair, Characteristics of Pb isotope evolution, 18: 33792
PAUL, E. B., Reaction $Ne^{23}(d,n)Na^{23}$, 18: 34832
PAULSEN, A., Prog. rpt. on cross section measurements of neutron-induced threshold reactions, 5/64, 18: 34753 (EANDC(E)-50(L))
PAULSEN, Paul J., Determination of active H by NMR spectrometry, 18: 33475
PAVLICHENKOV, I. M., Vibration-rotation interaction in deformed nuclei, 18: 34846
PAVLOV, V. S., Evaporation during thermal dissociation of Yb and La beryllides, 18: 34154
PAYNE, Burton S., Jr., Cementation coatings for refractory metals, 18: 34091
PEARCE, J. B., Milne problem in finite domain. I., 18: 34746
PEARL, J., Current distribution in superconducting film, 18: 34688
PEARSON, J. D., Gamma radiation produced in γ reactions on O-16, 18: 34829
PEARSON, Robin, Improvements in nuclear reactors, 18: 35101
PECA, O., Effect of physostigmine on irradiated rats, 18: 33306
PEDROCCHI, E., Liquid volume fraction in two-phase adiabatic flow, 18: 33732 (EURAEC-1086)
PEGEL, B., Collective behavior of classical plasma, 18: 34982
PEGORARO, L., Labeling of chromosomes of human leukemia cells, 18: 33253
PEKAREK, L., Electron temperature in positive column of electric discharge, 18: 34299
PELLERIN, P., High-activity dusts isolated in fallout, 18: 33770 (SCPRI(S)-99)
PELLERIN, P., Internal contamination from radioactive fallout, 18: 33429
PELLERIN, P., Public Health in the domain of radioprotection, 18: 33816
PELTE, D., Angular correlation measurements in Ne-21, 18: 34849
PENDLEBURY, E. D., Neutron surface multiplications of transport containers, 18: 34726 (AWRE-O-21/64)
PENNINGTON, R. T., Prog. rpt. on nuclear superheat fuel, 12/63–2/64, 18: 35145 (GEAP-4566)
PEREGOOD, B. P., High-precision prism β spectrometer, 18: 33948
PEREYSHVILI, E. A., Effect of certain hormones on hemopoiesis and survival of irradiated mice, 18: 33416
PEREZ-MESA, Carlos, Post-irradiation carcinoma of cervix uteri, 18: 33296
PERFILOV, N. A., Angular correlation between fragments in multiple formation, 18: 34940
PERFILOV, N. A., Spectrum of α particles in Cm-244 spontaneous fission, 18: 34955
PERKINS, C. D., Prog. rpt. on lattice and electronic defects in solids, final, 6/64, 18: 34280 (NYO-2680-1)
PERKINS, Roger A., Forming of refractory metal sheet, 18: 34107
PERLOW, G. J., Existence and structure of $XeCl_4$, 18: 33559
PERLOW, M. R., Existence and structure of $XeCl_4$, 18: 33559
PERRIN, Francis, Radioactive contamination of cultures, 18: 33239
PERRY, Harold, Planning radiation treatment on the computer, 18: 33434
PERSANO, Aldo, Errors in determination of leak rate in reactor containers, 18: 33757
PERSCHKE, D., Level indication measurements, wetting, and bubble indication of liquid Na in stainless steel container, 18: 33827 (EUR-1823.d)
PERSSON, Boerje, Internal bremsstrahlung from P-32, Sr-89, Y-90, Y-91, and Bi-210, 18: 34837
PERSSON, P. O., Reaction $Fe^{54}(p,\gamma)Co^{57}$, 18: 34792
PETER, M., Paramagnetic resonance of S-state ions in metals, 18: 33587
PETERKOP, R. K., Scattering of electrons on Li atoms, 18: 34429
PETERS, B., Propagation of cosmic rays through the atmosphere, 18: 34485
PETERSON, Laurence E., Positron-electron ratio of precipitating electrons, 18: 34479
PETERSON, M. N. A., Sedimentary profile across the North Atlantic, 18: 33790
PETERSON, Russell E., Large fast nuclear reactor, 18: 35125
PETERSON, V. Z., Sigma photoproduction from CH_2, 18: 34566
PETHES, Gyorgy, Capacity of I-131 to concentrate in skin of animals of different species, 18: 33251
PETRASOVA, Maria, Contribution to Sr-90 determination in fallout and soil, 18: 33776
PETREMENT EGUILUZ, J. C., Solvent-extraction applied to analysis of U. II., 18: 33680 (JEN-137-DQ/I-41)
PETREMENT EGUILUZ, J. C., Solvent-extraction applied to analysis of U. III., 18: 33681 (JEN-138-DQ/I-42)
PETREMENT EGUILUZ, J. C., Solvent extraction systems applied to U analysis. I., 18: 33679 (JEN-136-DQ/I-40)
PETREMENT EGUILUZ, J. C., Spectrophotometric determination of U, 18: 33463 (JEN-139-DQ/I-43)
PETROVIC, B., Radiation contamination of animal foods, 18: 33255
PETROVICH, I. K., Remote sequelae of affection of dogs with Sr-90, 18: 33342
PETRUNKIN, V. A., Scattering of low-energy photons on zero-spin particle, 18: 34538
PETUKHOV, M. I., Effect of ACTH and cortisone on testes of irradiated albino rats, 18: 33256
PEWITT, E. G., Low-temperature seals for plastic windows, 18: 34685
PFLUGER, Allen R., Electron beam welding, 18: 34112
PHILLIPS, R. H., Structure in π-p total cross section, 18: 34584
PHONG-CHAU, Nguyen, Unified field theories of Einstein-Schroedinger type, 18: 34642
PICAR, F., Elastic scattering of deuterons by Sr and Sn isotopes, 18: 34942
PICAR, F., Inelastic scattering of deuterons by Sn even isotopes, 18: 34941
PICHAKHCHI, L. D., Heat transfer in conducting fluid at small Reynold's number, 18: 34359
PIERCE, E. T., Variation of potential gradient with altitude, 18: 33773
PIERCE, R. Dean, Pyroprocessing of reactor fuels, 18: 33683 (TID-8540(p.411-76))
PIGACHE, D., Reflex discharge as a propulsion device, 18: 34290
PIGG, J. C., Radiation effects in Sb-doped Ge, 18: 34238
PIGORINI, F., Representation of the pancreas by scintigraphy, 18: 33442
PIKE, E. R., Green's function approach to the many-body problem, 18: 34661
PILERI, A., Labeling of chromosomes of human leukemia cells, 18: 33253
PILLINGER, W. L., Recoilless γ emission after α decay, 18: 34920
PILPENKO, A. T., Analysis of high-melting compounds, 18: 33474 (FTD-TT-63-814)
PINES, D., Nonlinear plasma oscillations, 18: 34523
PINES, Herman, Advances in catalysis. XIV., 18: 33453
PINGEL, J. H., Radiation accidents and emergencies, 18: 33817
PINKAU, K., Significance of measurement results in cosmic radiation, 18: 34476
PINKHASIK, M. S., Transient regimes of natural circulation in multi-circuit reactor system, 18: 35081
PIRANI, Conrad L., Radiation nephritis, 18: 33288
PIRINGER, O., Poisoning during isotopic exchange reaction between H and H_2O, 18: 33527 (IFA-28-IS)
PISCHINGER, Franz, Apparatus for irradiation or vacuum-coating of specimens, 18: 33763
PITTS, J. N., Jr., Uranyl-photosensitized reaction with tetrabutylammonium iodide, 18: 33628
PLAJNER, Z., Decay of Re-186, 18: 34805
PLATT, A. M., Prog. rpt. on fixation of radioactive residues, 1–3/64, 18: 35234 (HW-81862)
PLATZMAN, P. M., Fermi-liquid effects in cyclotron resonance, 18: 35045
PLESHAKOV, V. F., Determination of parameters and phase shifts for low-energy πN scattering, 18: 34621
PLESKOVA, Anna, Metabolism of Ce-144, 18: 33252
PLEVE, A. A., Formation of fissioning isomer in capture of neutrons by Au, 18: 34759 (JINR-D-1693)
PLIS, Yu. A., Focusing properties of sextupole magnet, 18: 34369 (JINR-P-1681)
PLUHAR, Z., Isotropic harmonic oscillator eigenvectors in $|n_1n_2n_3|$ and $|nlm|$ representations, 18: 34807
POBEDINSKII, M. N., Effects of radiation on ovaries, pregnancy, and the fetus, 18: 33395
POBEDINSKII, N. M., Effects of radiation on ovaries, pregnancy, and the fetus, 18: 33395
POCHIN, E. E., Radiation exposure of tissues and excretion rate of nuclides, 18: 33428
POCHOLLE, G., Wave propagation at very low temperature, 18: 34694
PODERGIN, V. A., Production of Al–Ce alloys, 18: 34099
PODGORETSKII, M. I., Instruments with feedback loop enclosing radiation source, 18: 33844 (AEC-tr-6399(p.10-20))
PODGORETSKII, M. I., Method for determining magnetic moment of Σ^+

hyperon, 18: 34623
POKROVSKII, E. A., Effect of ACTH and cortisone on testes of irradiated albino rats, 18: 33256
POKROVSKII, V. L., Phase transition in superconductors, 18: 34719
POLIKANOV, S. M., Formation of fissioning isomer in capture of neutrons by Am, 18: 34759 (JINR-D-1693)
POLIKANOV, V. S., Relativistic atomic photoeffect, 18: 34847
POLIKARPOV, G. G., Radioecology of marine organisms, 18: 33230
POLKINGHORNE, J. C., Fermion Regge trajectories in perturbation theory, 18: 34558
POLLACK, Arnold, Practical radiation testing, 18: 34223
POLLACK, Gerald L., Solid state of rare gases, 18: 34355
POLOMIK, E. E., Tests on EVESR MK I fuel bundle, 18: 35144 (GEAP-4560)
POLUEKTOV, N. S., Separation of rare-earth elements into subgroups, 18: 33689
POLYAK, L. Ya., Photometric determination of Zr in Mg and Al alloys, 18: 33512
POLYAKOV, A. I., Geochemistry of Th in syenites, 18: 33797
POLYAKOV, V. K., Critical boiling heat transfer, 18: 33743
PON, G. A., CANDU power costs competitive with BWR, 18: 35172
POPOVA, A. M., Four-body problem at low energies, 18: 34519
POPOVA, Anna M., Breakup of a deuteron by a nucleon, 18: 34535
PORILE, Norbert T., Ranges of low-energy Ga atoms in Cu and Zn, 18: 34441
PORTER, C. E., Neutron-nucleus optical model parameter effects on s-wave transmission coefficients, 18: 34866
PORTER, F. T., Electron response of NaI(Tl), 18: 33902
POSPISHIL, M., Energy balance and radiation sensitivity in rats, 18: 33365
POSPISIL, M., Radiosensitivity in mice, 18: 33321
POTEKHINA, N. A., Breaks in x chromosome under influence of radiation, 18: 33378
POUROVA, V., Preparation of active UO_3, 18: 33533 (UJV-725/63)
POVH, B., Angular correlation measurements in Ne-21, 18: 34849
POWERS, W. E., Demonstration of an anoxic component in mouse tumor-cell population, 18: 33379
POZDNIKOV, V. N., Automatically separating potato tubers from lumps of ground in harvesting machine, 18: 33991 (AEC-tr-6399(p.277-85))
POZDNIKOV, V. N., Control device for using modulated radioactive radiation, 18: 33843 (AEC-tr-6399(p.1-9))
POZDNIKOV, V. N., Radioactive instruments for automatization in chemical industry, 18: 33990 (AEC-tr-6399(p.258-76))
PRADAL, J., Nuclear structure calculations for deformed nuclei, 18: 34781 (UCRL-11376)
PRADEL, J., Trapping of I by active charcoals, 18: 33808 (AEC-tr-6459)
PRAKASH, A., Neutron binding energies in heavy nuclei, 18: 34966
PRASAD, K. G., Decay of Pt-197m, 18: 34879
PRATO, E. Lo, Mossbauer effect analyzer, 18: 33834 (RT/EL(63)-15)
PREISER, H. S., Cavitation damage in liquid Na, 18: 34075 (NASA-CR-54071)
PREPOST, R., Fine-structure constant from muonium hfs interval, 18: 34921
PRESCOTT, D. M., Frequency of sister chromatid exchanges following x rays, 18: 33329
PRESPERIN, V., Polarization measurements with protons scattered on C, 18: 34809
PRESTON, K., Jr., Early detection of altered blood-cell production, 18: 35256
PRIBIL, R., Complexometric determination of Zr, 18: 33503
PRICE, C. E., Thermoelectric properties of cubic U monocompounds, 18: 34142
PRICE, Glenn A., Reactor-physics for water-moderated lattices of slightly enriched U, 18: 35113 (TID-8540(p.529-609))
PRILL, A. L., Activated sintering of W, 18: 34098
PRIMER, M., Decay modes and properties of the X^0, 18: 34592
PRINCE, C. E., Jr., Ionospheric transmission of transversely propagated plane waves, 18: 34679
PROKESH, A., Reaction $\pi^- + Xe \rightarrow \pi^- + \pi^0 + Xe$ for 9-Bev/c primary π^- mesons, 18: 34949
PROKHONCHUKOV, A. A., Metabolism of C^{14}-tagged lysine in calcified tissues during acute radiation sickness, 18: 33346
PROKOPCHUK, A. Ya., Trace elements in radiation dermatitis, 18: 33285 (JPRS-25502)
PROKOSHKIN, D. A., Kinetics and mechanism of oxidation of Nb–Mo alloys, 18: 34078
PROKUDINA, E. A., Functional state of adrenals after irradiation, 18: 33367
PROMISEL, N. E., Conference on refractory metals, Oslo-Blindern, 6/63, 18: 34068
PROMISEL, N. E., Why refractory metals?, 18: 34201
PROSENZ, K., Effect of γ radiation on *Saccharomyces cerevisiae*, 18: 33393
PROSSER, F. W., Jr., Interference effects in $Li^7(p,\gamma)Be^8$ reaction, 18: 34875
PROTASOVA, T. N., Decomposition of histidine in livers of irradiated mice, 18: 33359
PRUSKI, S., Approximate second-order fermion density matrix, 18: 34525
PUCK, Theodore T., Cellular aspects of mammalian radiation syndrome, 18: 33351
PUGH, Stanley F., Metallic fuels, 18: 34130 (TID-8540(p.331-410))
PURDIE, N., Kinetics of some related electron-transfer reactions, 18: 33550
PURMAL, G. W., Electron bombardment and contact ion engines, 18: 33698
PUTMAN, William E., Jr., Temperature distribution and thermal stresses in radiation-cooled circular cylinders, 18: 33740 (SC-DC-64-891)
PUTNAM, G. E., TOPIC—FORTRAN program for calculating transport of particles in cylinders, 18: 34729 (IDO-16968)
PUTZ, Karel, Linear low-noise pulse amplifier for radiation detectors, 18: 33898
PYSHIN, V. K., Transient regimes of natural circulation in multicircuit reactor system, 18: 35081

Q

QAADRI, M. S., Karachi nuclear power project, 18: 35183
QUANG, Ho Kim, Effect of quadrupole collective motions on giant dipole resonance, 18: 34908
QUEBERT, J. L., Reaction in two states $^8Li(^6Li,\alpha)^8Be^*$, $^8Be^* = 2\alpha$, 18: 34819
QUEEN, N. M., Corrections to impulse approximation for elastic N-d scattering, 18: 34537
QUESNE, C., Exchange contribution to elastic scattering of α particles, 18: 34801
QUIMBY, Edith H., Resin uptake of I^{131}-triiodothyronine as test of thyroid function, 18: 33437
QUINN, E. P., Prog. rpt. on transition boiling heat transfer, 4–6/64, 18: 33734 (GEAP-4646)
QUINN, John J., Electron-phonon interaction, 18: 34453
QUINN, John J., Properties of quantum plasma, 18: 34985

R

RAAEN, Helen P., Fabrication of vertical-orifice Teflon capillary of Teflon dropping-Hg electrode, 18: 33451 (ORNL-3654)
RABB, David D., Block caving, nuclear style, 18: 33710
RABIK, L. L., Excitation of Ne atoms by electrons, 18: 34430
RACOVEANU, N., Radiochemical analysis of urine, 18: 33519
RADEBOLD, R., MHD impact flow-tube problem proposal, 18: 35166 (ANL-Trans-38)
RADHAKRISHNAMURTI, P. S., Limitations on isotopes in reaction mechanisms. II., 18: 33985
RADICATI, L. A., Spin and unitary spin independence of strong interactions, 18: 34582
RADICELLA, R., Production of I-131 from irradiated UO_2, 18: 33620 (NP-14187)
RADUTSKII, G. M., Relativistic corrections to s and p waves of π-N scattering, 18: 34507 (JINR-E-1686)
RAFF, L. M., Reactive collisions in molecular beams: $K + CH_3I$, 18: 33564
RAINES, B. A., Radiation effects on Nissl granules in rat spinal cord neurons, 18: 33349
RAJAGOPAL, A. K., Extended random-phase approximation, 18: 35002
RAJAGOPAL, V., Reactor noise measurements on Saxton reactor, 18: 35156 (TID-7679(p.427-47))
RALEIGH, Henry D., Bibliography on systems for nuclear auxiliary power, 18: 35204 (TID-3561(Rev.4))
RAMSDEN, S. A., Radiation scattered from plasma, 18: 34348
RANDALL, R. L., Application of power spectra to reactor-system analysis, 18: 35071 (TID-7679(p.107-33))
RANKOWITZ, S., Time-shared time-of-flight analysis by computer, 18: 33958
RAO, G. Gopala, New oxidimetric reagent. IV., 18: 33496
RAO, P. Kanta, New oxidimetric reagent. IV., 18: 33496
RASEMAN, Chad J., Commercial power reactors cooled with Na, D_2O, or organic liquids, 18: 35161 (TID-8540(p.71-129))
RASTALL, Peter, Quaternions in relativity, 18: 34667
RASULOV, D., Gamma exposure meter, 18: 33854 (AEC-tr-6399(p.221-6))
RATCLIFFE, C. A., Integrator for neutron dose-rate meter, 18: 33878 (HW-81774)
RAU, Robert C., Electron microscopy of irradiated BeO, 18: 34226
RAUD, M. O., Excretion of estrogens and steroids in irradiated cervical carcinoma, 18: 33287
RAUSHENBAKH, M. O., Bone marrow transplantation to irradiated dogs, 18: 33337
RAWALAY, S. S., Properties of I^{131}-labeled iodobenzoic acids, 18: 33614
RAY, A. D., Treatment of Sr-90-bearing organic waste by ion exchange,

18: 35240
RAYNOR, G. V., Constitution of Y–Ce and Y–La alloys, 18: 34160
RAYNOR, G. V., Lattice spacings of Th–Ce alloys, 18: 34161
RAZUMOVSKII, N. O., Remote sequelae of affection of dogs with Sr-90, 18: 33342
READER, Paul D., Large modules and arrays of electrostatic thrustors, 18: 33704
REAGAN, J. B., Satellite instrumentation for measurement of auroral phenomenon, 18: 33935
REAMES, Donald V., Charged-particle emission in heavy-ion interactions, 18: 34780 (UCRL-11349)
REBER, Elwood F., Hemorrhagic diathesis in rats fed irradiated beef, 18: 33992
RECHENBERG, H., Physics of elementary particles. I., 18: 34599
RECHNITZ, G. A., Cerium(IV)–oxalate reaction in acidic sulfate media, 18: 33537
RECHT, H. L., Prog. rpt. on effects of radiation on Ni–Cd battery electrodes, final, 6–12/63, 18: 34213 (AI-64-11)
REED-HILL, R. E., Basal slip kink bands in polycrystalline Zr, 18: 34193
REES, J. R., Electroproduction of protons at 1 and 4 Bev, 18: 34916
REID, F. J., Electrical properties of rare earth compounds and alloys, 18: 34158
REID, George C., Auroral absorption of radio waves, 18: 34254
REIF, R., Inelastic nucleon scattering on deformed nuclei, 18: 34865
REIF, R., Pattern of s-wave neutron intensity function, 18: 34787
REIGNIER, J., Phenomenological model of π^+ meson-proton elastic scattering, 18: 34533
REIN, James E., Adsorption of young fission products on various surfaces, 18: 33448 (IDO-14644)
REINES, F., Large liquid scintillator for detection of antineutrino reactions, 18: 33901
REINHARDT, P. W., Neutron dosimeter utilizing fission foil, 18: 33979
REITAN, Arne, n-p Photodisintegration of heavy nuclei, 18: 34925
REITZNER, B., Sodium azide crystals containing N-13 recoil atoms, 18: 33663
REIZENSTEIN, Peter, Building material for low-radioactivity laboratories, 18: 35050
REKALO, M. P., Fermion Regge poles in processes involving vectons, 18: 34620
REME, Henri, Tritium-loaded targets used in accelerators producing neutrons, 18: 34375
REMEIKA, J. P., Bromine NMR in ferromagnetic $CrBr_3$, 18: 33584
REMY, M. L., Internal contamination from radioactive fallout, 18: 33429
RESIBOIS, P., Transport equation of a Brownian particle, 18: 34349
REUS, N., Polarization effects in dielectrics irradiated with x rays, 18: 33622
REVAI, J., Symmetry properties of Nogami's modified pairing hamiltonian, 18: 34890
REWAJ, T., X-irradiation effect on shape of dielectric hysteresis loop in triglycine sulfate, 18: 34242
REXROAD, R. E., Point-to-point kernel analysis to determine wall penetration of γ radiation, 18: 35055
REYES-SUTER, P., Decay of Ag-106m to Pd-106, 18: 34817
REYNOLDS, Geo. T., Evaluation of image intensifier system, 18: 33221
REYNOLDS, J. H., Rare gases in Renazzo chondrite, 18: 34390
REYNOLDS, S. A., Counting methods and radiotracers, 18: 33655
RHOADES, W. A., SNAP reactor handbook—transient analysis, 18: 35201 (NAA-SR-9368)
RHODENIZER, R. L., Prog. rpt. on superconducting properties of materials, 12/15/63–6/15/64, 18: 34683 (NP-14136)
RICCI, E., Calculating induced radioactivity and decay, 18: 34012
RICE, Stuart A., Calculation of molecular friction constant, 18: 34308
RICHARD, Marc, Recovery energy of BeO irradiated with neutrons, 18: 34227
RICHARDS, Albert G., Image-retaining panel, 18: 33443
RICHARDS, R. E., Quadrupole relaxation in N nuclear resonances, 18: 33615
RICHTER, G. W., Review of experimental pathology. Vol. II., 18: 33229
RICKARD, C. L., Impact of graphite fuel development on steam generation, 18: 35176
RICKE, Werner, Preparation of SO_3 for determination of S^{32}/S^{34} in compounds, 18: 33501
RICKER, C. W., Negative reactivity measurement by neutron fluctuation analysis, 18: 35074 (TID-7679(p.171-81))
RIECK, G. D., Thermophysical properties of refractory metals, 18: 34207
RIEDEL, C., X-γ correlation by stripping reactions, 18: 34873
RIGHINI, B., Tunnel-diode fast discriminator, 18: 33835 (RT/EL(64)-3)
RIHAN, T. H., Direct interaction in heavy ion reactions, 18: 34856
RINALDI, Renaud, Radioprotective activity of nitrogenous heterocyclic compounds, 18: 33406
RINDFLEISCH, Carl, ρ Exchange mechanism in reaction $\pi^+ + p \rightarrow N_{33}^{++} + \pi^0$, 18: 34626
RINGOT, Claude, Improvements in reactor fuel element, 18: 35133
RISKEVICS, K. F., Corrosion behavior of ATR materials of construction, 18: 34074 (IDO-24460)
RISTIC, M. M., Sintering process for UO_2 according to Pines theory, 18: 34048 (NP-14124)
RITCHEY, Neil, Transporting spent fuel, 18: 33822
RITCHIE, E. E., Corrosion behavior of ATR materials of construction, 18: 34074 (IDO-24460)
RITTENBERG, Alan, Additional properties of 959-Mev meson, 18: 34515 (UCRL-11431)
RITTENBERG, D., Influence of nuclear mass on biological systems, 18: 33258
RITTER, Frank, Patient simulation in x-ray therapy, 18: 33435
RIVET, Ernest Jean-Marie, Investigation of highly populated levels of $(d_{5/2})^{\frac{1}{2}}$ and $(f_{7/2})^{\frac{1}{2}}$ configurations by (α,d) reaction, 18: 34779 (UCRL-11341)
RIZA-ZADE, R. R., Application of radiations in hydroponics, 18: 33997
ROBBINS, J. M., Characterization of spheroidal UO_2 particles and fabrication variables for fuel plates, 18: 34088 (ORNL-3645)
ROBERTS, A., Direction and velocity of nuclear particles, 18: 33977
ROBERTS, Arthur, Advances in spark chamber techniques, 18: 33923
ROBERTSON, W. W., Atomic emission of the He afterglow, 18: 34419
ROBERTSON, W. W., Intensity in a He afterglow, 18: 34310
ROBINSON, John E., Oral effects of radiotherapy, 18: 33422
ROBINSON, L. C., Modulated reflection plasma interferometer, 18: 35022
ROBINSON, R. L., Nuclear resonance and Coulomb excitation in $Na^{24}(p,p')$ reaction, 18: 34836
ROBINSON, W. S., Enzymatic synthesis of RNA. III., 18: 33245
ROBKIN, M. A., Prog. rpt. on Pu recycle for use in H_2O-moderated reactors, 4–6/64, 18: 35128 (GEAP-4642)
ROCHE, R., Thermodynamic cycles of nuclear and conventional power plants, 18: 35169
ROCHET, M., Delayed radionecroses of central nervous system, 18: 33290
RODDICK, Ronald G., Solid-state time-to-pulse-height converter, 18: 33930
RODERICK, Thomas H., Prog. rpt. on population genetics of mice under irradiation, 7/63–6/64, 18: 33281 (TID-20844)
RODGERS, J. W., Radiation damage in Li-drifted p-i-n junctions, 18: 33914
RODIONOV, B., Streamer chamber, 18: 33965
RODIONOVA, V. M., Radioprotective properties of ACTH, 18: 33411
RODRIGUEZ, M. Lopez, Reduction of UF_6 in closed bombs. I., 18: 33542
ROGACHEV, V. P., Radioactive instruments for automatization in chemical industry, 18: 33990 (AEC-tr-6399(p.258-76))
ROHRMANN, C. A., Fission products, 18: 33983 (HW-SA-3080(Rev.))
ROHRMANN, C. A., Radioisotopic space power, 18: 34002
ROKHLIN, L. L., Disintegration of saturated solid solution of Nd in Mg, 18: 34148
ROMANOV, Yu. I., Spin correlations in scattering of the neutrino and antineutrino, 18: 34614
ROMANS, Peter A., X-ray spectrographic analysis for trace quantities of Ta in Nb, 18: 33458 (BM-RI-6483)
ROMANTSEV, E. F., Change in composition of liver lipid of irradiated animals, 18: 33360
ROME, Martin, Multiplier phototubes for the far ultraviolet, 18: 33905
ROME, Martin, Photon scintillator, 18: 33908
RONY, Peter R., Electromagnetic levitation of metals, 18: 34057 (UCRL-11411)
ROOS, C. E., Determination of the Σ^+ magnetic moment, 18: 34591
ROOS, Charles E., Sigma photoproduction from CH_2, 18: 34566
ROOT, D. C., Properties of coated refractory and superalloy sheet, 18: 34128 (RTD-TDR-63-4068)
ROSCISZEWSKI, Jan, Ionizing shock wave interacting with EM field, 18: 34333
ROSE, P. H., Production of intense negative He and H ion beams, 18: 34381
ROSE, R. G., Gamma attenuation coefficients, 18: 35058
ROSEN, Hyman, Effect of D_2O on wound healing, collagen, and metabolism, 18: 33250
ROSEN, S. P., Unitary symmetry and weak interactions. II., 18: 34570
ROSEN, Seymour, Radiation nephritis, 18: 33288
ROSENBERG, Allan, Hot H displacement reaction with isobutane, 18: 33640
ROSENBERG, D. L., Darkening of powdered basalt by simulated solar-wind bombardment, 18: 34392
ROSENBERY, J. W., Development status of low-power arc-jet engines, 18: 33705
ROSIN, Ya. A., Radiation effects on acetylcholine and sympathin content in brain, 18: 33325
ROSS, D. A., High-level whole-body counter, 18: 33937
ROSS, H. H., Liquid scintillator for thermal neutron detector, 18: 33953
ROSS, J., Scattering of K by HCl and HI in crossed molecular beams,

18: 33560
ROSS, R. R., Scanning and measuring projector, 18: 33957
ROSSI, J., K Auger group intensities in Cl-37, 18: 34789
ROSSI, J., K Auger effect in Br-79, 18: 34788
ROSSIN, A. D., Dosimetry for radiation damage studies, 18: 34263 (ANL-6826)
ROSYANOV, S. P., Contamination of vegetation by Sr-90 and Cs-137, 18: 33235 (AEC-tr-6448)
ROTHBERG, J. E., Fine-structure constant from muonium hfs interval, 18: 34921
ROTHENBACHER, R., Niobium–gas systems, 18: 34177
ROTHENBACHER, R., Physical properties of refractory metals, 18: 34205
ROTHENSTEIN, W., Reactor physics research at Israel Research Reactor, 18: 35218 (IA-892)
ROTHMAN, S., Clinical significance of percutaneous absorption, 18: 33224
ROUGE, Pierre, Improvements in support structures for moderator blocks, 18: 35100
ROUSSET, A., Structure in π-p total cross section, 18: 34584
ROUX, Andre, Recovery energy of BeO irradiated with neutrons, 18: 34227
ROWE, D. J., Inelastic scattering of 147-Mev protons from C-12, 18: 34816
ROWELL, M. H., Solute distribution in Na_2O–B_2O_3–NaCl system. II., 18: 33534 (USNRDL-TR-760)
RUARK, Arthur E., Note on classical fields, 18: 34669
RUBBIA, C., Resonance in the dipion mass region 280 to 350 Mev, 18: 34552
RUBIN, Philip, Microangiography as a technique, 18: 33289
RUBY, L., Determination of total neutron yield from D(d,n)He^3 and T(d,n)He^4 reactions, 18: 34815
RUDD, M. Eugene, Prog. rpt. on distribution of electrons from gases ionized by proton impact, 4–7/64, 18: 34404 (COO-1277-5)
RUDNICK, A., Refractory ceramics of interest in aerospace structural applications, 18: 34129 (RTD-TDR-63-4102(Suppl. I))
RUDOLPH, P. S., Glass blowing on apparatus contaminated with radioactive or toxic materials, 18: 33718
RUDOLPH, W., Comparison of (n,γ) and (d,p) reaction in Co, 18: 34827
RUEDL, E., Observations on annealed- and ion-bombarded SAP foils, 18: 34038 (EUR-1833.e)
RUFEH, Firooz, Solubility of He in UO_2, 18: 34055 (UCRL-11043)
RUGGLES, P. C., Improvements in light amplifier operation, 18: 33906
RULLEAU, Alain, Improvements in reactor fuel element, 18: 35133
RUMLER, Chirad, Linear low-noise pulse amplifier for radiation detectors, 18: 33898
RUNDO, J., Assessment of radioactive Cs in man, 18: 33265
RUPP, A. F., Reactor by-products, 18: 33984 (TID-8540(p.477-528))
RUSEK, Vlastimil, Metabolism of Ce-144, 18: 33252
RUSINOV, A. I., Electrodynamics of superconductors, 18: 34721
RUSSELL, J. E., Fission cross section of Pu-241, 18: 34914
RUTGAIZER, V. D., Gamma relays for drops in radiation intensity, 18: 33846 (AEC-tr-6399(p.30-40))
RUTHERFORD, Sherman L., High-vacuum sputter-ion gettering apparatus, 18: 33875
RUTHERFORD, W. M., Effects of γ radiation on fresh strawberries, 18: 33993
RYABYSHEV, A. M., Kinetics and mechanism of oxidation of Nb–Mo alloys, 18: 34078
RYBACH, L., Neutron activation analysis of traces of Na in quartz, 18: 33494
RYBAKOV, V. N., Reaction (p,pπ^+) on In-115, 18: 34946
RYDEN, D. J., Image intensifier system for observation of nuclear events, 18: 33909
RYLSKY, Gregory Vladimir, Device for measuring gas pressure, 18: 33874
RYZHOV, N. I., Biological effects and RBE of high-energy protons, 18: 33286 (UCRL-Trans-1068)

S

SACHS, Ch., Physicochemical form of radioelements, 18: 33590
SACHS, L., Forssman-antigen synthesis in hamster and mouse cells, 18: 33317
SAFFORD, G. J., Low-frequency motions in isotactic and atactic polypropylene by neutron inelastic scattering, 18: 34265 (BNL-7320)
SAFINA, I. N., Photoneutron spectra from Pt, Bi, Pb, and U, 18: 34945
SAFRONOV, A. P., Decomposition of histidine in livers of irradiated mice, 18: 33359
SAGERMAN, Robert H., Radiation nephritis, 18: 33332
SAHA, Sachindra Nath, Paper chromatographic separation of Th, Zr, and U, 18: 33505
ST. PIERRE, G. R., Refractory metal-gaseous environment interaction, 18: 34083
SAJI, Yoshio, Numerical differential cross sections of $Ca^{40}(p,d)Ca^{39}$ at 55 Mev, 18: 34757 (INSJ-72)
SAKAI, Eiji, Disintegration rates of Am-241, 18: 34813
SAKAKURA, Arthur Y., Dynamics of ionized media, 18: 34971 (ARL-64-85)
SAKASHITA, Shiro, Neutrino pair emission from excited nuclei, 18: 34932
SAKHNOVSKII, E. G., Equations for partially ionized gas in strong magnetic field, 18: 35018
SAKOVICH, V. A., Technique for study of shielding properties, 18: 34374
SAKSONOV, P. P., Biological action of cosmic radiation in flights, 18: 33354
SAKSONOV, P. P., Radiation safety in flights of Soviet cosmonauts, 18: 33815
SAKURAI, Yoshifumi, Disintegration rates of Am-241, 18: 34813
SALA, Andre, Control of Siloe, 18: 35227
SALA, Jose M., Treatment of postirradiationally recidivated cancers of the cervix uteri, 18: 33444
SALCICCIOLI, G. G., Analytical uses of bromanilic acid, 18: 33498
SALMON, G. L., Inelastic scattering of 147-Mev protons from C-12, 18: 34816
SALTSBURG, H., Atomic-beam scattering from epitaxially grown Au films, 18: 34420
SAMELSON, H., Laser phenomena in Eu chelates. IV., 18: 33561
SAMIOS, N. P., Decay modes and properties of the X^0, 18: 34592
SAMOILOV, P. S., Low-energy γ transitions in Pu-238 and Pu-240, 18: 34798
SAMSONOV, G. V., Production of Al–Ce alloys, 18: 34099
SAMSONOVYM, G. V., Analysis of high-melting compounds, 18: 33474 (FTD-TT-63-814)
SAMUELI, J. J., Transistorized fast pulse amplifier, 18: 33861
SANDALLS, F. J., Determination of Pu in urine, 18: 33677
SANDERSON, E. A., Particle-hole description of Pb-208, 18: 34889
SANDERSON, E. A., Particle-hole description of odd-parity states of Ca-40, 18: 34831
SANDLER, S. R., Organometallics in plastic scintillators and γ radiation, 18: 33939
SANDRONI, Santino, Low-frequency vibrations of crystalline biphenyl, 18: 34302
SANGIUST, V., Activation analysis of D by $C^{13}(d,n)N^{13}$ reaction, 18: 33486
SANO, A., Automatic counting scaler, 18: 33884 (RT/EL(64)-7)
SANO, Tadao, Formation of UC_{1-x} N_x, 18: 33576
SANSOM, W. H., Non-destructive testing in marine nuclear power plant. I., 18: 35206
SANSOM, W. H., Non-destructive testing in marine nuclear power plant. II., 18: 35207
SANSOM, W. H., Non-destructive testing in marine nuclear power plant. III., 18: 35208
SANTAR, I., Angular dependence of spin densities on protons of CH_3 group, 18: 33548
SARACHIK, M. P., Resistivity of Mo–Nb and Mo–Re alloys, 18: 34183
SARAZIN, A., Transistorized fast pulse amplifier, 18: 33861
SARKER, A. Q., Gauge-invariant theory of neutral vector mesons, 18: 34606
SASAKI, Yasuo, Production of crude Nb metal, 18: 34067
SATCHLER, G. R., Distorted-waves theory of direct nuclear reactions, 18: 34835
SAUDER, William C., Standard reference wave lengths for x-ray spectroscopy, 18: 34341
SAUNDERS, G. A., Superconducting energy gap in Tl, 18: 34701
SAUR, G., Deformation of Zr sheets during oxidation, 18: 34081
SAUVE, Andre, Criticality experiments with annular cylinders containing Pu solutions, 18: 34494 (CEA-R-2495)
SAVAGE, C. H., Properties of coated refractory and superalloy sheet, 18: 34128 (RTD-TDR-63-4068)
SAVENKO, I. A., Multiple scattering of 75- to 200-kev protons in solids, 18: 34943
SAVIN, M. V., Photoneutron spectra from Pt, Bi, Pb, and U, 18: 34945
SAVINO, Joseph M., Laminar forced convection in rectangular channels, 18: 33746
SAVITSKII, E. M., Anisotropic properties of Sc monocrystals, 18: 34147
SAWADA, Katuro, Linearized many-body problem, 18: 34342
SAWYER, George A., Neon VII and VIII wave lengths in vacuum ultraviolet, 18: 34384
SAXER, R. K., Investigation of the $PbMoO_4$–$Bi_2(MoO_4)_3$ phase diagram, 18: 34195
SAYERS, J., Langmuir probe to measure electron temperatures and densities in afterglows, 18: 34999
SAYRE, E. D., Radioisotopic space power, 18: 34002
SCARDEFIELD, J. E., Doping of alkaline earth halide single crystals, 18: 34159
SCHAARSCHMIDT, Alfred, Continuous γ-ray spectrometry, 18: 33941
SCHAEFER, H., Investigation of Kr-85 bremsstrahlung sources. V., 18: 34287 (NP-tr-1160)
SCHAFFNER, K., Photochemical rearrangement of steroids, 18: 33635

SCHAFFNER, K., Uv irradiation of 11-oxo-steroids. IV., 18: 33634
SCHECHTER, J., Prediction of a $\pi\eta$ resonance, 18: 34572
SCHEEPER, J. H., Effects of telecobalt therapy on the pericardium, 18: 33327
SCHENID, E. J., Neutron binding energies in heavy nuclei, 18: 34966
SCHENK, M., Changes of crystal structure by neutron irradiation, 18: 34241
SCHERFF, Hans-Ludwig, Determination of trace Pa-231, 18: 33495
SCHEUER, W., Decay of Ag-106m to Pd-106, 18: 34817
SCHEYER, Gerry, Grinding W carbide, 18: 34095
SCHILLER, P., Radiometric determination of ash in vegetable drugs, 18: 33480
SCHINDEWOLF, U., Direct transformation of nuclear energy into chemical energy, 18: 33629
SCHINDEWOLF, Ulrich, Physical nuclear chemistry, 18: 33676
SCHIRBER, J. E., Electric field gradient in metallic In, 18: 33585
SCHLAGER, Gunther, Prog. rpt. on population genetics of mice under irradiation, 7/63–6/64, 18: 33281 (TID-20844)
SCHLUETER, D. J., Interference effects in $Li^7(p,\gamma)Be^8$ reaction, 18: 34875
SCHMIDT, Paul W., Certain integrals containing the Bessel function $J_0(x)$, 18: 34022
SCHMIDT, W., Investigation of Kr-85 bremsstrahlung sources. V., 18: 34287 (NP-tr-1160)
SCHMITT, H. W., Time-of-flight measurements of fission fragments with semiconductor detectors, 18: 33955
SCHMITT, R. W., Prog. rpt. on superconducting properties of materials, 12/15/63–6/15/64, 18: 34683 (NP-14136)
SCHMOKE, M. A., Point-to-point kernel analysis to determine wall penetration of γ radiation, 18: 35055
SCHNEIDER, A. M., Electron bombardment and contact ion engines, 18: 33698
SCHNEIDER, H., Lifetime of 37-kev level of Br-80, 18: 34845
SCHNEIDER, J., Modification of radiation damage in rats by splenectomy, 18: 33415
SCHOEN, Edgar J., Effect of local irradiation on testicular androgen biosynthesis, 18: 33316
SCHOENWETTER, Henry D., High-pressure steam power cycles and superheat steam cycles of reactors, 18: 35188
SCHOFFA, G., Electron spin resonance in biology, 18: 33227
SCHOLZ, W., Angular correlation measurements in Ne-21, 18: 34849
SCHRAM, E. P., High-temperature protective coatings for graphite, 18: 34043 (ML-TDR-64-173(Pt.I))
SCHREIBER, D. S., Superconducting behavior of superimposed thin films of Al and Sn, 18: 34723
SCHREIBER, R. E., Gamma heating in reactor experiments, 18: 34236
SCHRIEFFER, J. R., Electron-phonon interaction and superconductivity, 18: 34722
SCHROCK, V. E., Fission distribution in seven-pin cluster fuel elements, 18: 35131
SCHUCK, E. A., Uranyl-photosensitized reaction with tetrabutylammonium iodide, 18: 33628
SCHUELKE, Lothar, Nuclear β decay. I., 18: 34937
SCHUELKE, Lothar, Nuclear β decay. II., 18: 34938
SCHUEMANN, W. C., Effects of electron-surface interaction in ionization gages, 18: 33759 (AD-427830)
SCHULT, O., Decay of 23.5-min U-239, 18: 34850
SCHULTZ, H., Quenching study on W, 18: 34138
SCHULTZ, M. A., Shutdown reactivity measurements using noise techniques, 18: 35072 (TID-7679(p.135-54))
SCHULTZ, Rolf C., Radiochemical polymerization of monomers, 18: 33674
SCHULTZ, T. D., Two-dimensional Ising model, 18: 34356
SCHULZ, G. J., Vibrational excitation of N_2, CO, and H_2 by electron impact, 18: 34440
SCHUSSLER, M., Prog. rpt. on Nb (Cb-752) alloy, 7–11/63, 18: 34025 (AD-428036)
SCHWARTZ, Mel M., Electron beam welding of refractory metals, 18: 34092
SCHWEITZER, Donald G., Removal of radiation damage from graphite, 18: 34230
SCHWEMIN, A. J., Scanning and measuring projector, 18: 33957
SCHWOERER, Frank, Jr., Nuclear power today and tomorrow, 18: 35178
SCOSSIROLI, R. E., Prog. rpt. on mutability of polygenes, 4/64, 18: 33279 (TID-20823)
SCOTT, Charles D., Combustion of graphite–U fuels, 18: 33682 (ORNL-P-200)
SCOTT, S. A., Reactor physics research at Israel Research Reactor, 18: 35218 (IA-892)
SCOZZAFAVA, R., Thermal parameters and neutron spectra in organic moderators, 18: 34734
SEARS, W. C., Infrared spectra of plastics and elastomers after irradiation, 18: 34220 (TID-20787)
SEBILLE, Claire, Electron spectrum of W-187 transmutation, 18: 34804
SEELY, L. B., Shock reflection in high-explosive shock tube, 18: 34332
SEGAL, I., Reactor physics research at Israel Research Reactor, 18: 35218 (IA-892)
SEGRE, G., Commutation relations of weak currents, 18: 34657
SEGUIN, Maurice, Nuclear irradiation enclosure arrangement, 18: 35230
SEIDL, M., Instability in a mirror machine, 18: 35008
SEIDLER, H., Distribution and solubility of Sr-90 in bones of animals, 18: 33240
SEIFE, Burton, Determination of two γ-emitting radioisotopes, 18: 33489
SEIGLE, Leslie L., Developing refractory metal alloys, 18: 34203
SEILER, R. F., Cross sections for $O^{16}(d,p_0)O^{17}$, $O^{16}(d,p_1)O^{17*}$ and $O^{16}(d,\alpha)N^{14}$, 18: 34860
SEKI, Yoshinobu, Thermal conductivity of UO_2, UC, and UC_2, 18: 34172
SEKIYA, Tamotsu, Experiments using Osaka University HITS. I., 18: 35225
SEKIYA, Tamotsu, Neutron distribution in hydrogenous moderators, 18: 34736
SELFRIDGE, Ralph G., Digital reduction of data in noise analysis, 18: 35077 (TID-7679(p.301-5))
SELTE, Kari, Crystal structure of $NbTe_4$, 18: 34136
SELTE, Kari, Structural properties of $Nb_{1+x}Se_2$ phase, 18: 34137
SELZER, Reinhold, Photoreactivation of uv-inactivated polyuridylic acid, 18: 33392
SEMERDZHYAN, S. P., Removal of newly gathered potato tubers from dormant stage, 18: 33376
SEN, Amiya K., Kelvin-Helmholtz instability in plasma, 18: 35003
SEN, Hari K., Collision effects in hydromagneto-ionic theory, 18: 35038
SENHOUSE, L. S., Jr., Excited states of Li-6 observed through $He^4(d,d)He^4$, 18: 34867
SENNETT, C. T., Infrared absorption of H^- and D^- ions in CaF_2, 18: 34262 (AFCRL-64-284)
SEPTIER, Albert, Energy losses by rare gas ions after collisions with rare gas atoms, 18: 34416
SEREBRENNIKOV, I. Ya., Radioactive density meter, 18: 33848 (AEC-tr-6399(p.138-52))
SEREDA, G. A., Strontium-90 content in fresh water reservoirs, 18: 33769 (NP-14091)
SERGEYEV, A. V., Barometric coefficient of neutron component, 18: 34467 (NASA-TT-F-126(p.215-19))
SERMON, G. Ya., Propagation of EM field impulse in moving conduction medium, 18: 34320
SERVOZ-GAVIN, Pierre Emile, Improvements in devices for measuring small magnetic fields, 18: 33870
SESELY, V., Electron temperature in positive column of electric discharge, 18: 34299
SETTI, R. Levi, Properties of very high-energy inelastic processes from measurements on recoil baryon, 18: 34632
SEVCIK, Augustin, Physics of heavy water lattices, 18: 35120
SEVERGNINI, L. Tonolini, Analysis of (n,α) nuclear reactions, 18: 34810
SEWELL, Kenneth G., Properties of high-temperature He, 18: 34289
SHABUDIN, S. A., Automatically separating potato tubers from lumps of ground in harvesting machine, 18: 33991 (AEC-tr-6399(p.277-85))
SHAFER, G. V., Temporal variations of different components of cosmic rays, 18: 34463 (NASA-TT-F-126(p.81-101))
SHAFER, Yu. G., Stratospheric investigations of intensity of cosmic rays, 18: 34465 (NASA-TT-F-126(p.187-93))
SHAFER, Yu. G., Temporal variations of different components of cosmic rays, 18: 34463 (NASA-TT-F-126(p.81-101))
SHAFRANOVA, M. G., Elastic p-p scattering at 8.3 Bev, 18: 34508 (JINR-P-1674)
SHALASHOV, V. A., Influence of γ irradiation on malleable cast Fe, 18: 34229
SHAL'NOV, M. I., Radiolysis of thymidine, 18: 33658
SHALTIEL, D., Paramagnetic resonance of S-state ions in metals, 18: 33587
SHAMOV, V. P., Absorbed dose from prolonged intake of Ra-226, 18: 33821
SHAND, J. B., Positron annihilation in divalent metallic oxides, 18: 33605
SHANNON, Robert Dey, Anatase-rutile transformation, 18: 35253 (UCRL-11001)
SHAPIRO, F. L., Scattering length and cross section for neutron radiative capture, 18: 34762 (JINR-P-1671)
SHAPIRO, Joseph, Prog. rpt. on reactions produced when antiprotons annihilate on protons, final, 18: 34511 (NYO-2584-1)
SHAPIRO, Kenneth A., Fourth sound in He II, 18: 34725
SHAPIRO, Sidney, Prog. rpt. on superconductive effects in films, 7/15–10/15/63, 18: 33824 (AD-428788)
SHAPOVAL, E. A., Electrodynamics of superconductors, 18: 34721
SHARKHATNYAN, R. O., Polarization of cosmic muons, 18: 34490
SHAROV, V. T., Ion-exchange unit for production of reactor feed water, 18: 33713
SHARP, Jack, Improvements in radioactivity contamination monitors,

18: 33973
SHARP, L., Velocity of hydromagnetic ionizing fronts in cylindrical geometry, 18: 35009
SHARPE, Jack, Nuclear radiation detectors, 18: 33967
SHEEHAN, T. V., Downflow packed-bed nuclear fission reactor, 18: 35124
SHEEN, E. M., Integrator for neutron dose-rate meter, 18: 33878 (HW-81774)
SHEFT, Irving, Preparation and melting point of XeF_6, 18: 33593
SHELDON, R., Insulation for 11-kv 280-kg pulsed magnet, 18: 33717
SHELINE, Raymond K., Coriolis anti-pairing and blocking effects in deformed even-even nuclei, 18: 34775 (TID-20875)
SHELINE, Raymond K., Low-lying collective states of Sm-152 and Sm-154, 18: 34913
SHELINE, Raymond K., Nuclear reaction $Y^{89}(d,p)Y^{90}$, 18: 34834
SHEPHERD, G. G., Photoelectric scanning system for auroral height measurements, 18: 34674
SHERMAN, F. G., Prog. rpt. on biosynthesis of proteins by living cells, 3/63–6/64, 18: 33212 (NYO-2570-1)
SHERMAN, Irvin S., Electron response of NaI(Tl), 18: 33902
SHERMAN, Irvin S., Transient response of semiconductor detectors, 18: 33919
SHERMAN, S., Product property and cluster property equivalence, 18: 34313
SHERWEN, R. G., Hunterston station, 18: 35177
SHERWIN, R., Radiation-resistant magnetic amplifier controls, 18: 33825 (AD-435095)
SHERWOOD, E. M., Less-common metals for process equipment, 18: 34151
SHIELD, E., Polarization of 40-Mev protons, 18: 34550
SHILOH, M., Chemistry of Np(III), Pu(III), and Am(III) in halide solutions, 18: 33526 (IA-924)
SHIMANSKAYA, N. S., Mean energy of Pr-142 β spectra, 18: 34954
SHIMIZU, Sakae, Positron emission in decay of Eu-152, 18: 34820
SHIMOKAWA, Junichi, Isotopic exchange reaction between U(IV) and U(VI) ions. I., 18: 33577
SHIRATO, Shoji, Semiconductor detectors for fission fragments, 18: 33945
SHIRIKOV, V. P., Boundary value problem for equations of mathematical physics, 18: 34269 (JINR-P-1682)
SHIROKOV, Yu. M., Connections between local operators and the scattering matrix, 18: 34541
SHISHKOV, P. P., Variations of cosmic rays at 9 to 12 kilometers, 18: 34464 (NASA-TT-F-126(p.180-6))
SHISTER, A. R., Particle flux and temperature in plasma in strong magnetic field, 18: 35027
SHKERIN, N., High-temperature oxidation of Nb–Mo–Cr alloy, 18: 34080
SHLAER, W., Electroproduction of protons at 1 and 4 Bev, 18: 34916
SHMELEVA, N. I., Changes in peripheral blood on irradiation, 18: 33363
SHOBER, F. R., Effect of space environment on materials, 18: 34235
SHOHNO, Naomi, Low-temperature properties of interacting Bose system, 18: 34665
SHPIGEL, I. S., Particle losses and configuration of plasma jet moving along curved magnetic field, 18: 35023
SHPIZ, J. M., Pais's charge correlation coefficients, 18: 34530
SHREIR, L. L., Oxidation of U–Al compounds. I., 18: 34077
SHTILBANS, I. I., Hereditary and chromosomal diseases during analysis of sequelae of radiation, 18: 33336
SHUMILOVSKII, N. N., Control device for using modulated radioactive radiation, 18: 33843 (AEC-tr-6399(p.1-9))
SHUMILOVSKII, N. N., Dosing system for automatic control device, 18: 33851 (AEC-tr-6399(p.177-85))
SHURCLIFF, W. A., Cambridge electron accelerator, 18: 34367 (CEAL-1000)
SHURYN (SHURIN), A. K., Crystal structure of Nb–Co β phase, 18: 34145
SHUSTER, Robert C., DNA of uv-irradiated *E. coli*, 18: 33298
SHVEDOV, V. P., Contamination of vegetation by Sr-90 and Cs-137 18: 33235 (AEC-tr-6448)
SIBRANS, Dyrc F., Scintillation scanning of kidneys, 18: 33433
SICHA, M., Electron temperature in positive column of electric discharge, 18: 34299
SIEGBAHN, K., Double-focusing β spectrometer (50 cm), 18: 33947
SIEGEL, Robert, Laminar forced convection in rectangular channels, 18: 33746
SIEGEL, Robert, Nucleate boiling under normal and reduced gravity conditions, 18: 33736 (NASA-TN-D-2299)
SIEMIARCZUK, T., π^0 Production in π^-p interactions at 10 Bev, 18: 34542
SIL, N. C., Phase shift calculation of electron scattering, 18: 34528
SILBERT, M. G., Inelastic scattering of 2- to 5-Mev neutrons by Fe, 18: 34740
SILER, William, Patient simulation in x-ray therapy, 18: 33435
SILHA, M., Radiosensitive factors of cellular proliferation, 18: 33307
SILKER, W. B., Corrosion isotopes in half-plant low alum feed H_2O treatment, 18: 35193 (HW-78431)
SILKER, W. B., Corrosion isotopes in half-plant low pH coolant, 18: 35194 (HW-78964)
SILOBRCIC, V., Autografts and homografts in sublethally irradiated rats, 18: 33386
SILVER, A. H., Quantum interference effects in superconductors, 18: 34696
SILVERMAN, S. R., Petroleum origin and evolution mechanisms, 18: 33783
SILVESTRI, M., Liquid volume fraction in two-phase adiabatic flow, 18: 33732 (EURAEC-1086)
SIMENAUER, A., Electrorefining of U in molten salt bath, 18: 34093
SIMMONS, G. J., Full-scale submarine test facility, 18: 33709 (SC-TM-64-636)
SIMONS, H. A. B., Comparison between collimator theory and experiment, 18: 33969
SIMONS, L., Investigation of reaction $K^{40}(p,\gamma)Ca^{40}$ at 1103, 1131, and 1153 kev, 18: 34784
SIMPSON, Charles L., Ground-level air exposures resulting from emissions from stacks at Hanford, 18: 33801 (HW-80204)
SIMPSON, H. M., Nuclear powered surface-effect ships design problems, 18: 35215
SIMPSON, J. A., Evidence for >30-kev electrons accelerated in earth's magnetospheric boundary, 18: 34680
SIMPSON, O. D., Fission cross section of Pu-241, 18: 34914
SINCLAIR, W. K., Polyploidy induced by x rays in Chinese hamster cells *in vitro*, 18: 33383
SINGER, Evzen, Determination of Cu, Hg, and Ag in pure U compounds, 18: 33509
SINGER, Evzen, Fluorescence of U in melts, 18: 33506
SINGER, Paul, Vector-meson production in meson-baryon collisions, 18: 34567
SINGER, Robert M., Removal of radiation damage from graphite, 18: 34230
SINGH, Ajit, Radiolysis of cyclohexanone. I., 18: 33623
SINGH, Ajit, Radiolysis of cyclohexanone. II., 18: 33624
SINGH, M., Rayleigh scattering of γ rays, 18: 34417
SIPS, Leopold, Interaction of four like nucleons in same shell, 18: 34863
SISAKYAN, N. M., Biological action of cosmic radiation in flights, 18: 33354
SJODAHL, L. H., Orientation in extruded BeO, 18: 34167
SJOELANDER, A., Phonons and external radiation, 18: 34624
SKALKA, M., Liberation of desoxy-ribo-poly-nucleotides from irradiated tissues, 18: 33308
SKILLICORN, Ian, High-energy separated beam for 80-in. chamber, 18: 34365 (BNL-8145)
SKLYARENKO, I. P., Analysis of ternary mixtures in ionization gas analyzers, 18: 33471 (AEC-tr-6399(p.92-7))
SKOFRONICK, J. K., Detailed forms of yield curves from semi-thick Al targets, 18: 34917
SKOPINA, V. I., High-precision prism β spectrometer, 18: 33948
SKORUPSKI, Andrzej, Introduction to plasma theory, 18: 35029
SKORUPSKI, Andrzej, Problems in magnetogasdynamics. I., 18: 35028
SKORUPSKI, Andrzej, Theory of plasma stability, 18: 35031
SKREPPEN, H., Steel irradiation program, 18: 34219 (RCN-26)
SKRIPIN, G. V., Temporal variations of different components of cosmic rays, 18: 34463 (NASA-TT-F-126(p.81-101))
SLARK, N. A., Improvements in light amplifier operation, 18: 33906
SLATER, G. G., Intrascintillation vial reaction tube, 18: 33478
SLAUCITAJS, L., Quiet-day solar daily magnetic variations, 18: 34387
SLAUGHTER, Gerald M., Welding and brazing techniques for reactor components, 18: 34100
SLAVATINSKII, S. A., Interaction cross section and energy conserved by nucleons in collisions, 18: 34952
SLAVIN, V. I., Calculating radioactive source of density meter, 18: 33847 (AEC-tr-6399(p.124-37))
SLINEY, Harold E., Fused fluoride coatings as solid lubricants, 18: 33695 (NASA-TN-D-2348)
SLIV, L. A., Many-nucleon system in shell-model potential, 18: 34826
SLIZ, J., Elastic scattering of 24.7-Mev α particles, 18: 34902
SLOBODRIAN, R. J., Polarization of 40-Mev protons, 18: 34550
SLOTOVA, J., Effects of irradiation and of nucleic acids on chromosomes, 18: 33309
SLOTTOW, H. G., Crossed-field charged particle delay lines, 18: 34277 (NP-14134)
SLOVOKHOTOVA, N. A., Effect of radiation on polypropylene, 18: 34243
SLUSHER, R., Bromine NMR in ferromagnetic $CrBr_3$, 18: 33584
SLYUSARENKO, L. I., Elastic scattering of deuterons by Sr and Sn isotopes, 18: 34942
SMIGIELSKI, J., MGD phenomena in the case of pulsating combustion, 18: 34296
SMIRENNYI, L. N., Technique for study of shielding properties, 18: 34374
SMIRNOV, Yu. F., Nucleon cluster reduced widths, 18: 34891
SMITH, A. W., High-temperature protective coatings for graphite, 18: 34043 (ML-TDR-64-173(Pt.I))

SMITH, E. J., Collision-free MHD shock in interplanetary space, 18: 34393
SMITH, Gerald A., Production of $\Xi K(n)\pi$, $\Lambda K\bar{K}(n)\pi$, and $\Sigma K\bar{K}$ final states, 18: 34514 (UCRL-11430)
SMITH, Gerald A., Ξ^*(1530-Mev) spin and parity, 18: 34517 (UCRL-11436)
SMITH, J. H., Search for CP nonconservation in K_2^0 decays, 18: 34590
SMITH, Joe N., Jr., Atomic-beam scattering from epitaxially grown Au films, 18: 34420
SMITH, L. E., Vapor container leak rate test on CVTR, 18: 35141 (CVNA-208)
SMITH, L. F., Satellite instrumentation for measurement of auroral phenomenon, 18: 33935
SMITH, Robert J., Glass microdosimetry system, 18: 33880 (NDL-SP-6)
SMITH, Robert L., Deuterium content of phenocrysts, 18: 33788
SMITH, V. N., Electron drift-velocity detector, 18: 33476
SMITS, F. M., Radiation damage in Si avalanche diodes, 18: 34248
SMOLIN, D. D., Change in composition of liver lipid of irradiated animals, 18: 33360
SMOLIN, V. N., Critical boiling heat transfer, 18: 33743
SMOLUCHOWSKI, R., Prog. rpt. on lattice and electronic defects in solids, final, 6/64, 18: 34280 (NYO-2680-1)
SMULDERS, P. J. M., Levels of S-32 in $Si^{28}(\alpha,\gamma)S^{32}$ and $P^{31}(p,\gamma)S^{32}$ reactions, 18: 34924
SMYTHE, Rodman, Tables for ion energy determination, 18: 34934
SNAJDR, E. A., Fracture stresses of UO_2–W cermets, 18: 34124 (HW-79676)
SNOKE, Donald R., Silent mercury rankine cycle power system, 18: 33721
SNOW, A. I., Analysis of tower flooding with scintillation counter and Cs source, 18: 34000
SNOW, E. C., Total energies from numerical self-consistent field calculations, 18: 34437
SNOW, G. A., "U-spin equalities" and octet symmetry breaking, 18: 34586
SNYDER, Fred, Phospholipid patterns in livers accumulating fat, 18: 33493
SNYDER, Millard E., Nuclear fuel elements, 18: 35137
SOBON, J. T., Thermal conductivity of UC, 18: 34120 (CNLM-5621)
SOGAMI, Ikuo, Composite model of elementary particles, 18: 34613
SOH, W. Y., Diagnosis and treatment of cancer with radioactive isotopes. I., 18: 33438
SOHL, G., Electron bombardment and contact ion engines, 18: 33698
SOKOLOV, V. D., Stratospheric investigations of intensity of cosmic rays, 18: 34465 (NASA-TT-F-126(p.187-93))
SOKOLOV, V. D., Temporal variations of different components of cosmic rays, 18: 34463 (NASA-TT-F-126(p.81-101))
SOKOLOVA, G. N., Change in composition of liver lipid of irradiated animals, 18: 33360
SOLA, Alain, SPERT I destructive test program on Al, plate-type, water-moderated reactor, 18: 35220 (IDO-16883)
SOLOPOV, G. P., Radiation of Co-60 for combatting grey rot of strawberries, 18: 33998
SOLOV'EV, V. P., Radiation effects on cotton seeds, 18: 33333
SOLOV'EVA, Z. I., Spectrum of α particles in Cm-244 spontaneous fission, 18: 34955
SOLOVIEV, V. G., Excited states with $K\pi = 2+$ of even-even deformed nuclei, 18: 34760 (JINR-E-1696)
SOLTIS, Paul J., Size effect in Be wire, 18: 34126 (NAMC-AML-1550)
SONETT, C. P., Collision-free MHD shock in interplanetary space, 18: 34393
SOOD, B. S., Rayleigh scattering of γ rays, 18: 34417
SOROKIN, P. V., Energy levels of Si-28, 18: 34822
SOROKIN, P. V., Reaction $Al^{27}(d,\alpha)Mg^{25}$ at 1.5 to 2.6 Mev, 18: 34823
SOSIN, A., Point defect studies in Au. II., 18: 34249
SOSNOVSKII, A. T., Cigerol and linol treatment of radiation injuries of the skin, 18: 33413
SOSNOVSKII, A. T., Trace elements in radiation dermatitis, 18: 33285 (JPRS-25502)
SOTNICHENKO, A. L., Limiting values for activation of creep in Ti–Zr alloys, 18: 34152
SOTNIKOV, V. A., Gamma-absorption method for control of Pb content, 18: 33468 (AEC-tr-6399(p.61-71))
SOUERS, P. C., High-pressure effect on Dy, 18: 33592
SOYFER, V. N., Induction of h-mutations in extracellular phage T2 by γ irradiation, 18: 33297
SPARRMAN, P., Ground-state rotational band of Tm-169, 18: 34794
SPARRMAN, P., Lifetime of the 138.9-kev level in Tm-169, 18: 34795
SPARRMAN, P., Two lifetimes in ground-state rotational band of Tm-171, 18: 34796
SPEAR, R. H., Gamma radiation produced in γ reactions on O-16, 18: 34829
SPEIRS, Kenneth K., Prog. rpt. on Elk River reactor pressure vessel, 4–5/64, 18: 35154 (SWRI-1228-28)
SPEISER, Rudolph, Refractory metal-gaseous environment interaction, 18: 34083
SPENCER, Richard P., Determination of two γ-emitting radioisotopes, 18: 33489
SPERDUTO, A., Shell-model states in Ca-49, 18: 34905
SPERNER, F., Determination of small gas content in metals, 18: 33491
SPILLER, K.-H., Level indication measurements, wetting, and bubble indication of liquid Na in stainless steel container, 18: 33827 (EUR-1823.d)
SPINELLI, Franco, Safety of reactors on merchant ships, 18: 35209
SPINKS, Windsor S., Vacuum technology, 18: 33762
SPINRAD, R. J., Multiple neutron spectrometer control system, 18: 33876 (BNL-8180)
SPINRAD, R. J., Time-shared time-of-flight analysis by computer, 18: 33958
SPITTLER, Thomas M., Preparation and melting point of XeF_6, 18: 33593
SPJUT, Harlan J., Post-irradiation carcinoma of cervix uteri, 18: 33296
SPRATT, John S., Treatment of postirradiationally recidivated cancers of the cervix uteri, 18: 33444
SPRING, E., Investigation of reaction $K^{39}(p,\gamma)Ca^{40}$ at 1103, 1131, and 1153 kev, 18: 34784
SRIVASTAVA, K. D., Insulation for 11-kv 280-kg pulsed magnet, 18: 33717
SRIVASTAVA, S. N., Effect of metal ions on BSA-stabilized emulsions, 18: 33575
SROUBEK, Z., Resonance of F center in x-irradiated F^{19}-doped BeO, 18: 33657
STACY, J. T., Fabricability of refractory metals, 18: 34101
STAES, K., Vapor pressure of H, 18: 33588
STAMP, A. P., Radial distribution of the absorption potential, 18: 34854
STANG, J. H., Effect of space environment on materials, 18: 34235
STANLEY, V. A., Progress on photomultipliers and image intensifiers, 18: 33907
STARKE, K., Szilard-Chalmers effect in solid XeF_4, 18: 33666
STAROSTE, Erika, Observations on annealed- and ion-bombarded SAP foils, 18: 34038 (EUR-1833.e)
STECH, Berthold, Nuclear β decay. I., 18: 34937
STEELE, Edgar L., Automatic systems for biologic nuclear activation analyses, 18: 33464 (NASA-CR-52997)
STEELE, W. A., Self-diffusion coefficients and quantum equilibrium properties, 18: 34307
STEHLE, P., Causality condition for Schrödinger scattering, 18: 34597
STEHLIK, G., Trace element content of leukocytes by neutron activation analysis, 18: 33517
STEIN, Gabriel, Prog. rpt. on action of radiations on biological model systems, final, 6/63–6/64, 18: 33283 (TID-20889)
STEIN, R. P., Boiling "burnout" for reactor design, 18: 35162 (TID-8540(p.131-76))
STEINBERG, Herbert A., TRG-SGD—Monte Carlo program to calculate secondary γ dose from nuclear weapon detonation, 18: 34285 (WL-TDR-64-46(Vol.I))
STEINGRABER, O. J., Fluorescence decay-time measuring apparatus, 18: 33637
STEINLECHNER, D., Effect of γ radiation on *Saccharomyces cerevisiae*, 18: 33393
STEPHENSON, R. Rhoads, Electrically propelled lunar logistic vehicle, 18: 35210
STERLING, Theodor D., Planning radiation treatment on the computer, 18: 33434
STERN, A. G., Similar stagnation-point MHD flow, 18: 34319
STERN, T. E., Reactor impulse response using random source excitation and cross correlation, 18: 35075 (TID-7679(p.203-18))
STERN, T. W., Ancient granite gneiss in Black Hills, 18: 33768
STERNER, S., Energy levels of Mn-51, 18: 34793
STERNER, S., Reaction $Cr^{52}(p,\gamma)Mn^{53}$, 18: 34797
STERNHEIM, Morton M., Scattering of pions by light nuclei, 18: 34911
STEVENSON, Richard, Design of 300,000-oersted two-region solenoid, 18: 33714
STEWART, A. T., Positron annihilation in divalent metallic oxides, 18: 33605
STEWART, K., Modes of formation and properties of aerosol particles, 18: 33823
STEWART, R. J. J., Reaction $Si^{28}(\gamma,p)Al^{27}$, 18: 34901
STEWART, Samuel L., Large fast nuclear reactor, 18: 35125
STOHR, Jacques Andre, Improvements in reactor fuel element, 18: 35133
STOKES, R. J., Dislocation configurations and initiation of yielding in MgO, 18: 34123 (HR-64-269)
STONE, G. A., Creep of Nb at low temperatures, 18: 34119 (ATN-64(9236)-9)
STONE, J. A., Recoilless γ emission after α decay, 18: 34920
STONER, D. R., Prog. rpt. on weldability and elevated temperature stability of refractory metal alloys, 12/21/63–3/21/64, 18: 34058

(WANL-PR(P)-003)
STOOPS, C. E., Radiation-induced polymerization-modification of acrylonitrile, 18: 33650
STORM, M. L., Isotopic Hf resonance-absorption data, 18: 34883
STRAHAHAN, G., Meson effects in n-p capture, 18: 34915
STRAX, N., Nonsymmetrical property of magnetic monopoles, 18: 34291
STREFFER, C., Radioprotection efficiency of histamine in mice, 18: 33414
STRINGFELLOW, M. W., Exchange parameters in Fe–Ni alloys, 18: 34187
STROM, Thomas N., Fused fluoride coatings as solid lubricants, 18: 33695 (NASA-TN-D-2348)
STROMBERG, R. P., Weightlessness switch, 18: 35259
STRUGARU, D., Poisoning during isotopic exchange reaction between H and H_2O, 18: 33527 (IFA-28-IS)
STRUTINSKII, V. M., Surface nucleon stripping reactions, 18: 34951
STRZALKOWSKI, A., Elastic scattering of 24.7-Mev α particles, 18: 34902
STUART, R. N., Fission distribution in seven-pin cluster fuel elements, 18: 35131
STUHLINGER, Ernst, Electric propulsion in 1964, 18: 33702
STUNGIS, G. E., Optical absorption of the F and K bands in RbCl, 18: 34306
STUTIUS, W., Specific heat measurements of EuSe and EuTe, 18: 34695
STYCZEN, J., Hfs interaction of Gd-155 nucleus, 18: 34898
SUESS, Hans E., Urey-Craig groups of chondrites, 18: 34397
SUGAWARA, Tadashi, Nuclear magnetic resonance in nickel fluosilicate, 18: 34275 (NP-14114)
SUGIHARA, Ryo, Energy loss by sequence of fast charges in plasma, 18: 34996
SUGIMOTO, Osamu, The void and hole effect in D_2O-moderated reactor, 18: 35083
SUGIURA, Masaru, Plasma confinement device with reversed field. I., 18: 34993
SUICH, John E., Transport-theory calculations of temperature coefficients in heterogeneous reactor lattices, 18: 35118
SUITA, Tokuo, Experiments using Osaka University HITS. I., 18: 35225
SUITA, Tokuo, Neutron distribution in hydrogenous moderators, 18: 34736
SUKHOVA, L. A., Control-measuring instruments with radiation in building-materials industry, 18: 33852 (AEC-tr-6399(p.196-201))
SUMITA, K., Noise analysis of reactor systems, 18: 35073 (TID-7679 (p.155-69))
SUMMERS, Roy E., Construction of complete isodose distributions in Co teletherapy, 18: 33445
SUNDSTROEM, T., Ground-state rotational band of Tm-169, 18: 34794
SUNDSTROEM, T., Lifetime of the 138.9-kev level in Tm-169, 18: 34795
SUNDSTROEM, T., Two lifetimes in ground-state rotational band of Tm-171, 18: 34796
SUNKA, P., Instability in a mirror machine, 18: 35008
SURDIN, Maurice, Correlation function analysis of systems obeying linear differential equations, 18: 35078 (TID-7679(p.321-9))
SUTER, T., Decay of Ag-106m to Pd-106, 18: 34817
SUTHERLAND, Donald Mason, Improvements in nuclear reactors, 18: 35102
SUTIN, N., Kinetics of some related electron-transfer reactions, 18: 33550
SUTIN, N., Mechanisms of electron transfer reactions in solution, 18: 33521 (BNL-8081)
SUTTON, Doris C., Cerium-144 and Cs-137 in wheat, 18: 33818
SUZUKI, Teiro, Acoustic attenuation studies of frictional force on fast moving dislocation, 18: 34276 (NP-14129)
SVECHNIKOV, S. V., Internal photoeffect in CdS single crystals excited with x rays, 18: 34286 (AEC-tr-6399(p.186-95))
SWAN, P., Deduction of potentials from scattering phase-shift data, 18: 34635
SWANBERG, F., Jr., Mobile whole-body counter, 18: 33802 (HW-80216)
SWANSON, C. D., Recent PRTR kinetics tests using random signals, 18: 35111 (HW-81211)
SWARTZ, H. A., Liquid scintillation solvent systems, 18: 33938
SWARTZ, P. S., Prog. rpt. on superconducting properties of materials, 12/15/63–6/15/64, 18: 34683 (NP-14136)
SWEET, William H., Use of neutrons in treatment of neoplasms, 18: 33431 (TID-20856)
SWENSON, L. Wayne, Levels in Sc-42 from $Ca^{40}(He^3,p)Sc^{42}$, 18: 34960
SWERDLOW, Martin A., Radiation nephritis, 18: 33288
SWIDERSKI, E. F., Prog. rpt. on converter for nuclear thermionic energy source, final, 5/3–12/3/63, 18: 34497 (NP-12888(Vol.5))
SWIECKI, M., K^+-p scattering, 18: 34543
SWIFT, A., Form factors for medium and heavy nuclei, 18: 34928
SYCHKOV, M. A., Technique for study of shielding properties, 18: 34374
SZALAY, A., Fission-product precipitation in Hungary, 18: 33771
SZANIAWSKI, Andrzej, Problems of MGD equations, 18: 35034
SZANIAWSKI, Andrzej, Problems in magnetogasdynamics. I., 18: 35028
SZEGO, George, Space power systems—state of the art, 18: 34001
SZYBALSKI, Waclaw, Properties of 5-bromodeoxyuridine-labeled transforming DNA, 18: 33402

T

TABACHENKO, A. N., Relativistic corrections to s and p waves of π-N scattering, 18: 34507 (JINR-E-1686)
TABER, K. C., Brazing Be metal, 18: 34110
TACU, Gh., Polarization effects in dielectrics irradiated with x rays, 18: 33622
TAGLIAFERRI, E., Large aperture time-of-flight counter system, 18: 33972
TAHA, Ezz Eldin M., Studies on N-fixing blue-green algae. II., 18: 33237
TAKAHASHI, Shuichiro, Thermal conductivity of UO_2, UC, and UC_2, 18: 34172
TAKAKI, Hideo, Change of Curie temperature with pressure for Gd, 18: 34173
TALLACKSON, J. R., Reactor safety analysis, MSRE design, 18: 35152 (ORNL-TM-732)
TALLEY, Wilson K., Spatial-distribution functions, 18: 34745
TAMAGAKI, Ryozo, Nucleon-nucleon potential in the triplet-even state, 18: 34931
TAMURA, Hiroyuki, Disintegration rates of Am-241, 18: 34813
TANACA, Hiroshi, Measurement of plasma conductivity. I., 18: 35000
TANACA, Hiroshi, Measurement of plasma conductivity. II., 18: 35001
TANAKA, Eiji, Numerical differential cross sections of $Ca^{40}(p,d)Ca^{39}$ at 55 Mev, 18: 34757 (INSJ-72)
TANAKA, Kiyoo, Plasma confinement device with reversed field. I., 18: 34993
TANAKA, Sho, Parity doublet hypothesis of strange particles, 18: 34612
TANI, E., Nuclear needle for use in neurosurgery, 18: 33436
TARKOV, S. N., Application of radiations in hydroponics, 18: 33997
TASHPULATOV, Yu. T., IR spectra of acrylonitrile–α-methylfuran copolymers, 18: 33670
TASSAN, S., Fast fission factors in U–H_2O lattices, 18: 35117
TASSIE, L. J., Canonical quantization of Schroedinger equation, 18: 34639
TASSOUL, J. L., Gravitational stability of plasma, 18: 34990
TATE, R. E., Self-diffusion studies of delta Pu, 18: 34191
TAVENDALE, A. J., Semiconductor Li-ion drift diodes, 18: 33912
TAWARA, Hiroyuki, Characteristics of a duoplasmatron ion source, 18: 34377
TAYLOR, A., Constitution diagram of Nb–Hf, 18: 34163
TAYLOR, A. J., Characterization of spheroidal UO_2 particles and fabrication variables for fuel plates, 18: 34088 (ORNL-3645)
TAYLOR, Angela M., Accumulation of radionuclides by thornback ray, 18: 33248
TAYLOR, Howard S., Hartree-Fock wave function of atomic and molecular systems, 18: 34426
TAYLOR, Hugh P., Jr., Oxygen isotope analyses of tektites, soils, and impactite glasses, 18: 33787
TAYLOR, J. C., Induced pseudoscalar term in muon capture, 18: 34551
TAYLOR, N. A., Determination of radionuclides in urine, 18: 33518
TEETER, Charles E., Catalog of nuclear reactor concepts. Pt. I, Sec. I, 18: 35119 (ANL-6892)
TEICHMANOVA, M., Radiation effects on ketone extraction. II., 18: 33621 (UJV-977/64)
TENDYS, J., Damping of transverse plasma oscillations at ion cyclotron resonance, 18: 34974 (NP-14153)
TENNER, R. J., Factitial proctitis, 18: 33330
TEPLY, J., Radiation effects on ketone extraction. II., 18: 33621 (UJV-977/64)
TER-AKOPYAN, G. M., Proton decay of nuclei with $Z > 50$, 18: 34767 (JINR-P-1706)
TERASAWA, Shoichi, Hitachi Training Reactor (HTR), 18: 35224
TEREKHOVA, V. F., Anisotropic properties of Sc monocrystals, 18: 34147
TERENTEV, M. V., Regge poles and amplitude production of vector mesons, 18: 34622
TERENTEVA, E. A., Simultaneous determination of Zr and S in organic compounds, 18: 33514
TERRIEN, Jean-Francois, Pyrolysis and radiolysis in degradation of terphenyls, 18: 33619 (MITNE-48)
THEEWES, F., Vapor pressure of H, 18: 33588
Theodorus Henricus van Oers, Willem
see van Oers, Willem Theodorus Henricus
THIE, Joseph A., Noise sources in power reactors, 18: 35155 (TID-7679 (p.357-68))
THIELHEIM, K. O., Generalization of the endpoint method, 18: 35056
THIRUVENGADAM, A., Cavitation damage in liquid Na, 18: 34075 (NASA-CR-54071)
THODE, H. G., Isotope anomalies in Xe from meteorites, 18: 34399
THOM, J. R. S., Pressure drop during forced circulation boiling of H_2O, 18: 33745
THOMA, R. E., Phase equilibria in NaF–BeF_2–ThF_4 system, 18: 33582
THOMAS, C. W., Corrosion isotopes in half-plant low alum feed H_2O treatment, 18: 35193 (HW-78431)

THOMAS, C. W., Corrosion isotopes in half-plant low pH coolant, 18: 35194 (HW-78964)
THOMAS, Henry C., Retardation factors for ion exchange columns, 18: 33684
THOMAS, L., Decomposition kinetics during zone formation in Al–Mg alloys, 18: 34135 (AI-Trans-53)
THOMAS, Ludwig, Kinetics of decomposition of Al–Mg alloys, 18: 34244
THOMPSON, Gertrude, Hydrolytic polymerization in Cr(III) solutions, 18: 35255 (UCRL-11410)
THOMPSON, V. R., Dispersion-strengthened refractory alloys, 18: 34197
THOMPSON, Worthington, Improvements in or relating to shelters, 18: 33758
THOMSEN, John S., Standard reference wave lengths for x-ray spectroscopy, 18: 34341
THORNLEY, Margaret J., Radiation sensitivity of bacterial spores, 18: 33996
THORNLEY, Margaret J., Radiation sensitivity of vegetative bacteria, 18: 33326
THUNBORG, S., Jr., Compressed gas gun for controlled planar impacts over wide velocity range, 18: 33756
TIETZ, T. E., Tensile flow behavior of Mo, 18: 34194
TIKHINSKII, G. F., Deformation and fracture of rolled Be, 18: 34140
TIKHINSKII, G. F., Evaporation during thermal dissociation of Yb and La beryllides, 18: 34154
TIKHONOVA, L. A., Reaction $\pi^- + Xe \rightarrow \pi^- + \pi^0 + Xe$ for 9-Bev/c primary π^- mesons, 18: 34949
TILLAEV, R. S., IR spectra of acrylonitrile–α-methylfuran copolymers, 18: 33670
TILLER, H. J., Point-to-point kernel analysis to determine wall penetration of γ radiation, 18: 35055
TILLEY, J., Thickness of moving He-II film, 18: 34716
TILTON, G. R., Redistribution of Sr and Rb isotopes during metamorphism, 18: 33793
TISHCHENKO, M. A., Separation of rare-earth elements into subgroups, 18: 33689
TISINGER, Richard M., Jr., Differential cross sections for reaction $B^{11}(d,p)B^{12}$, 18: 34909
TITTMANN, B. R., Superconductivity in the artificial metals, 18: 34707
TOBIAS, Ivan, Electrothermal arc-jet propulsion system, 18: 33706
TOITA, Yukio, Spectrophotometric determination of Ce with TTA, 18: 33540
TOKAREVSKII, V. V., Elastic scattering of deuterons by Sr and Sn isotopes, 18: 34942
TOKAREVSKII, V. V., Inelastic scattering of deuterons by Sn even isotopes, 18: 34941
TOKARSKAYA, V. N., Damage to DNA structure *in vitro* by γ radiation, 18: 33356
TOLAR, J., Isotropic harmonic oscillator eigenvectors in $|n_1n_2n_3|$ and $|nlm|$ representations, 18: 34807
TOLKACHEV, B. V., Interaction cross section and energy conserved by nucleons in collisions, 18: 34952
TOLMACH, L. J., Demonstration of an anoxic component in mouse tumor-cell population, 18: 33379
TOMBRELLO, T. A., Excited states of Li-6 observed through $He^4(d,d)He^4$, 18: 34867
TOMLINSON, M., Radiation-decomposition of three low-melting organic coolants, 18: 33617 (AECL-1915)
TOMMASI, M., Delayed radionecroses of central nervous system, 18: 33290
TONGIORGI, E., Paleotemperature analysis of fossil shells of marine mollusks, 18: 33784
TONOLINI, F., Analysis of (n,α) nuclear reactions, 18: 34810
TORCHINSKAYA, O. L., Remote sequelae of affection of dogs with Sr-90, 18: 33342
TORELLI, G., Resonance in the dipion mass region 280 to 350 Mev, 18: 34552
TORRES, P., Partial stopping powers of H_2 and He gases for He atoms and ions, 18: 34456
TORRIE, B. H., Exchange parameters in Fe–Ni alloys, 18: 34187
TOUBES, R. O., Determination of radioactivity of minerals by x rays, 18: 33794 (NP-14176)
TOURASSE, Max, Prestressed concrete containers of G2 and G3, 18: 35196
TOURNISSOU, B., Determination of polar profile of synchrocyclotron magnet, 18: 34376
TOURYAN, K. J., Density distribution over moving circular plate in free-molecule flow, 18: 33742
TOUZIN, R., Activity measurement of β emitter radioelement, 18: 33946
TRAINOR, J. H., Neutron albedo measurements on polar orbiting satellites, 18: 34478
TRANH, Dinh Ky, Changes in effect of procaine on blood pressure of irradiated rabbits, 18: 33304
TRAPP, J. H., Process for preparation of U metal, 18: 33611
TRAVERSA, G., Thermal parameters and neutron spectra in organic moderators, 18: 34734
TRAVIS, J. C., High-level whole-body counter, 18: 33937
TREMEAU, O., Influence of culture conditions on radiation resistance of some lactobacilli, 18: 33293
TRET'YAKOV, E. F., New data on W-182 excited states, 18: 34953
TRICE, James B., Internal pulse amplification in Si p-n junction, 18: 33959
TRININ, V. D., Ion-exchange unit for production of reactor feed water, 18: 33713
TRIPP, Robert D., Search for $K^-p \rightarrow \Lambda\mu^+\mu^-$ or Λe^+e^- at 2.7 Bev, 18: 34513 (UCRL-11428)
TRNOVEC, Tomas, Metabolism of Ce-144, 18: 33252
TROZERA, T. A., Prog. rpt. on mechanical properties of reactor materials, 1/64, 18: 34039 (GA-5340)
TROZERA, T. A., Prog. rpt. on reactor materials, 10/62–9/63, 18: 34122 (GA-4900)
TRUGLIO, William, Surface effects in pulsed plasma accelerator, 18: 34980
TRYKOV, L. A., Spatial distribution of dose of scattered γ radiation, 18: 33810
TSAREV, V. A., Dispersion relations and KΛ photoproduction on a proton, 18: 34536
TSOU, K. C., Organometallics in plastic scintillators and γ radiation, 18: 33939
TSYPIN, A. B., Development of conditioned reflex to radiation in fish and rabbits, 18: 33366
TSYTOVICH, V. N., Interaction of longitudinal and transverse waves in plasma, 18: 35025
TUBIANA, Maurice, Physical basis of radiotherapy and radiobiology, 18: 33228
TUBIS, M., Properties of I^{131}-labeled iodobenzoic acids, 18: 33614
TUDOR, J. J., Service machine for gas-cooled reactors, 18: 35106
TULACH, J., Effect of physostigmine on irradiated rats, 18: 33306
TULINOV, A. F., Multiple scattering of 75- to 200-kev protons in solids, 18: 34943
TUMUL'KAN, A. D., Sources of x rays with Sr-90–Y-90 as base, 18: 33989 (AEC-tr-6399(p.243-57))
TURKOT, F., Magnitude of the K_1^0–K_2^0 mass difference, 18: 34593
TURNBULL, A. G., Zirconium difluoride, 18: 33544
TURNER, G., Rare gases in Renazzo chondrite, 18: 34390
TURNER, P. P., Preparation of high-purity BeO powder, 18: 34064
TURNER, R. W., Tuberculosis in Hiroshima, 18: 33225
TURSKI, Andrzej, Dispersion in plasma, 18: 35033
TURSKI, Andrzej, Problems in magnetogasdynamics. I., 18: 35028
TURUSOV, V. S., Affection of skin caused by β radiation, 18: 33340
TVERBAKK, O. P., BIGG-I—multigroup neutron spectrum and criticality code, 18: 34730 (KR-77)
TYAN, Marvin L., Sensitivity to skin grafts in mice, 18: 33388
TYASTO, M. I., Temperature effect for hard component of cosmic rays, 18: 34469 (NASA-TT-F-126(p.224-9))
TYMKO, R. R., Radiation-decomposition of three low-melting organic coolants, 18: 33617 (AECL-1915)
TZUR, Y., Precipitation of Sr by $CaCO_3$ in calcareous soils, 18: 33594

U

UCHIDA, Akira, Fast neutron time-of-flight system, 18: 33944
UCHIYAMA, T., Metabolic alterations after total-body doses of x radiation, 18: 33294
UENO, Y., Radiosensitivity in mice, 18: 33321
UETA, Masayasu, Low-temperature luminescence in alkali halide crystals under x irradiation, 18: 33648
UMEDA, Iwao, Transmission of singly scattered γ rays through finite thin slabs, 18: 35051
UMEDA, Iwao, Transmission of γ rays from Co-60 and Cs-137 point isotropic sources, 18: 35052
UPTON, Arthur C., Biological effects of ionizing radiations, 18: 33397
URBAN, P., Inelastic electron-deuteron cross section, 18: 34555
URIN, M. G., Vibration-rotational interaction in deformed nuclei, 18: 34950
URSU, I., Electron spin resonance of Mn(II) ion in zeolites, 18: 34268 (IFA-IS-27)
URSU, I., Poisoning during isotopic exchange reaction between H and H_2O, 18: 33527 (IFA-28-IS)
USHKOVA, T. V., High-temperature oxidation of Nb–Mo–Cr alloy, 18: 34080
USMANI, I. H., Nuclear Power in Pakistan, 18: 35257
USMANOV, Kh. U., IR spectra of acrylonitrile–α-methylfuran copolymers, 18: 33670

V

VACEK, A., Concentration of O in tissues and its relation to radiosensitivity, 18: 33404

VACLAVIK, J., High-frequency conductivity of plasma, 18: 34992
VAILATI, G., Nuclear needle for use in neurosurgery, 18: 33436
VALAT, Jean, Reactivity measurements using source excitation and correlation techniques, 18: 35076 (TID-7679(p.219-28))
VALENTIN, M., Measurements in 4π geometry on samples with weak β activity, 18: 33943
VALEVA, S. A., Combined action of mutagens and irradiation on barley seeds, 18: 33375
VALKOVIC, V., Angular distribution of tritons from reaction $B^{10} + n$ at 14.4 Mev, 18: 34830
VALLEE, Marie-Genevieve, Bibliography on radiation effects on corrosion, 18: 34036 (CEA-Bib-16)
VAL'TER, A. K., Calculating radioactive source of density meter, 18: 33847 (AEC-tr-6399(p.124-37))
VAL'TER, A. K., Measurement of humidity of friable bodies by neutron slowing-down method, 18: 33470 (AEC-tr-6399(p.83-91))
VAN ALLEN, J. A., Injun I observations during latter September-early October, 1961, 18: 34493
VAN ALLEN, J. A., Large diurnal variations of trapped and precipitated electrons, 18: 34480
VAN DEN BERG, G. J., Critical field of Nb superconductivity, 18: 34713
VAN DER BORGHT, R., Evolution of massive stars, 18: 34386
VANDERSLICE, J. T., Diffusion cross sections for N^+–N and O^+–O collisions, 18: 34418
VAN DER WALT, C. M., Slip dislocations and prismatic loops in Be, 18: 34168
VAN DER WOUDE, C. A. A., Fabrication of reactor steam generators, 18: 35093
VAN DUYSE, E., Effect of RNA and mononucleotides on restoration of radiolesions, 18: 33410
VAN ECK, J., Excitation of He by protons, 18: 34445
VAN HOOK, W. Alexander, Vapor pressures of some deuterated ethanes, 18: 33557
VAN ITTERBEEK, A., Vapor pressure of H, 18: 33588
VAN KLINKEN, J., Polarization measurements of β rays, 18: 34877
VAN KOLMESCHATE, C., Magnetic and caloric effects in a hard superconductor, 18: 34712
VAN LANCKER, J. L., Metabolic alterations after total-body doses of x radiation, 18: 33294
VAN MIDDELKOOP, G., Nuclear physics experiments with neutron beams, 18: 34799
VAN OERS, Willem Theodorus Hendricus, Interactions of deuterons with isotopes of H and He, 18: 34771 (NP-14175)
VAN OSDOL, J. H., Thermal testing of SNAP-10A prototype system (PSM-3), 18: 35200 (NAA-SR-9280)
VAN RIET, R., Rotation spectra of the $^{34}S^{16}O^{16}O$ molecule, 18: 34292
VAN RONGEN, H. J. M., Critical field of Nb superconductivity, 18: 34713
VARONEN, Jorma, Beta energies of Pr-143, S-35, and Pm-147, 18: 34785
VARSHAVSKAYA, E. S., Age of Ni-bearing pluton with K–Ar and Rb–Sr methods, 18: 33781
VARTANOV, N. A., Low-energy γ transitions in Pu-238 and Pu-240, 18: 34798
VASIL'EV, A. G., Hysteresis of thyratron relays, 18: 33845 (AEC-tr-6399 (p.21-9))
VASIL'EV (VASIL'YEV), G. A., Counters and dosimeters for studying shielding and protective properties of materials, 18: 33886 (JPRS-25467(p.9-24))
VASIL'EV (VASIL'YEV), G. A., Protective properties of concrete, 18: 35092 (JPRS-25467(p.1-8))
VASIL'EV, I. M., Effect of ionizing radiations on plants, 18: 33284 (AEC-tr-5836)
VASIL'EV, L. A., Effect of radiation on polypropylene, 18: 34243
VASIL'EVA, E. V., Kinetics and mechanism of oxidation of Nb–Mo alloys, 18: 34078
VEJE, E., Reactions (p,α) to N = 28 nuclei, 18: 34855
VELDRE, V. Yu., Excitation of Ne atoms by electrons, 18: 34430
VENARD, J. T., In-reactor stress-rupture properties of 20 Cr–25 Ni, 18: 34218 (ORNL-TM-881)
VENDE, G. V., Liquid scintillation counter for measurement of β activity of preparations in layers, 18: 33659
VENINGA, T. S., Radiomimetic toxicity of ozonized air, 18: 33334
VENNART, J., Measurements of Ra in Ra luminizers, 18: 33262
VENTERS, Lydia, Effect of ionizing radiations on plants, 18: 33284 (AEC-tr-5836)
VERA PALOMINO, J., Solvent-extraction applied to analysis of U. III., 18: 33681 (JEN-138-DQ/I-42)
VERA PALOMINO, J., Solvent extraction systems applied to U analysis. I., 18: 33679 (JEN-136-DQ/I-40)
VERA PALOMINO, J., Solvent-extraction applied to analysis of U. II., 18: 33680 (JEN-137-DQ/I-41)
VERA PALOMINO, J., Spectrophotometric determination of U, 18: 33463 (JEN-139-DQ/I-43)
VERBEKE, O., Vapor pressure of H, 18: 33588
VERBRAAK, C. A., Properties of refractory metals, 18: 34208
VERGA, Richard L., Thermonuclear reactions for space propulsion, 18: 34973 (ASD-TDR-63-696)
VERKHOROBIN, L. F., Reactions of $MoSi_2$ with Be, 18: 34149
VERKHOVSKII, B. I., Instruments with feedback loop enclosing radiation source, 18: 33844 (AEC-tr-6399(p.10-20))
VERKHOVSKII, B. I., Measurement of humidity of friable materials by neutron method, 18: 33466 (AEC-tr-6399(p.43-50))
VERLET, L., Integral equation for classical fluids, 18: 34336
VERNON, F. L., Jr., Behavior and structure of flux jumps in hard superconductor, 18: 34724
VERNOV, S. N., Cosmic rays, 18: 34461 (NASA-TT-F-126)
VESELKIN, A. P., Protective properties of concrete, 18: 35092 (JPRS-25467(p.1-8))
VESELY, V., Complexometric determination of Zr, 18: 33503
VESPE, Vincent, Nuclear materials management in nuclear safety, 18: 33799 (CONF-620-2)
Viedma Alonso, Luis Garcia de
see Garcia de Viedma Alonso, Luis
VINCENT, L. M., Chlorine trifluoride, 18: 33522 (CEA-2360)
VINDUSKA, M., $O^+ \leftrightarrow O^-$ β transitions, 18: 34808
VINH MAU, N., 2^+ States of O-16 with T = 0, 18: 34814
VINH MAU, Nicole, Particle-hole description of C-12 and O-16, 18: 34824
VINOGRADOV, A. P., Isotopic S composition of ore sulfides, 18: 33767
VINTERNITS, P., Optical theorem for scattering of particles with arbitrary spins, 18: 34618
VITKALENKO, L. P., Effect of γ irradiation of seeds on extracts of sugar beet leaves, 18: 33314
VITKALENKO, L. P., Radiation effects on amino acid content of wheat sprouts, 18: 33398
VIZDALOVA, M., Relation between radioresistivity of bacteria and their content of nucleic acids and proteins, 18: 33310
VLAHOVIC, S., Bone marrow aspiration in mice, 18: 33223
VLASES, George C., Experiments on MHD shock waves, 18: 35006
VLASINOVA, M., Origin of giant cells after irradiation, 18: 33405
VLASYUK, P. A., Effect of γ irradiation of seeds on extracts of sugar beet leaves, 18: 33314
VOBORIL, M., Preparation of active UO_2, 18: 33533 (UJV-725/63)
VOEVODINA, O. N., Effects of Br reflexes in healthy and x-irradiated dogs, 18: 33319
VOGEL, P., Electromagnetic transitions from collective to ground states of even-even deformed nuclei, 18: 34761 (JINR-E-1703)
VOLK, H. F., High-temperature protective coatings for graphite, 18: 34043 (ML-TDR-64-173(Pt.I))
VOLYNKIN, Yu. M., Radiation safety in flights of Soviet cosmonauts, 18: 33815
VON BAEYER, H. C., Statistics of pions, 18: 34628
VON BOECKH, R., Inner-outer exchange interactions of TlF molecule, 18: 34936
VON ROOS, Oldwig, Interaction of very intense radiation fields with atomic system, 18: 34458
VORMUM, G., Investigation of Kr-85 bremsstrahlung sources. V., 18: 34287 (NP-tr-1160)
VOZZELLA, P. A., Thermal decomposition of UC, 18: 33523 (CNLM-5619)
VOZZELLA, P. A., Thermal decomposition of UN, 18: 33524 (CNLM-5620)
VYSOTSKII, G. L., Polarization phenomena in direct nuclear reactions, 18: 34853
VYSOTSKII, G. L., Polarization phenomena in deuteron stripping reactions, 18: 34861
V'YUGOV, P. N., Thermal expansion of W, Mo, Ta, Nb, and Zr at high temperatures, 18: 34190

W

WABER, J. T., Total energies from numerical self-consistent field calculations, 18: 34437
WACKER, Adolf, Photoreactivation of uv-inactivated polyuridylic acid, 18: 33392
WADA, Masanobu, Nucleon-nucleon potential in the triplet-even state, 18: 34931
WADDINGTON, C. J., Hydrogen isotopes produced in solar flares, 18: 34382 (NP-14141)
WADDINGTON, J. F., Exchange scattering of slow electrons by H atoms, 18: 34446
WAGENER, H. W., Reactor metals and refractory metals, 18: 34180
WAGHMARE, Yeshwant R., Shape independence of low-lying states of nuclei, 18: 34906
WAGNER, F., Jr., Electron response of NaI(Tl), 18: 33902
WAGNER, H. A., Progress on advanced methods of power generation, 18: 34499

WAGNER, W. A., Effect of space environment on materials, 18: 34235
WAGONER, C. C., Vapor container leak rate test on CVTR, 18: 35141 (CVNA-208)
WAGONER, Joseph K., Cancer mortality among underground metal miners, 18: 33813
WAHLBORN, S., Nuclear structure calculations for the $2^-(\beta)2^+(\gamma)0^+$ decays of Rb-86 and Rb-84, 18: 34874
WAINE, Peter, Nuclear reactor fuel elements, 18: 35135
WAINERDI, Richard E., Automatic systems for biologic nuclear activation analyses, 18: 33464 (NASA-CR-52997)
WAKITA, Shohei, Low-temperature luminescence in alkali halide crystals under x irradiation, 18: 33648
WALKER, B. D., Neutron spectra from the (p,n) reaction, 18: 34859
WALKER, D. A. S., Automatic sample changer for α-, β-, and γ-active sources, 18: 33716
WALKER, E. Harris, Relationship for plasma sheaths about Langmuir probes, 18: 35043
WALKER, J. K., Electroproduction of protons at 1 and 4 Bev, 18: 34916
WALLACE, W. E., Magnetic characteristics of CeF_3, 18: 34156
WALLERSTEIN, George, Abundances in K giant stars. I., 18: 34385
WALTER, F. J., Fission fragment pulse-height response of Si surface barriers, 18: 33915
WALTER, R. J., Determination of H in Nb, 18: 33538
WALTERS, G. P., Slip dislocations and prismatic loops in Be, 18: 34168
WALTON, G. N., Review of hot atom chemistry, 18: 33660
WAN, J. K. S., Uranyl-photosensitized reaction with tetrabutylammonium iodide, 18: 33628
WARD, C., Large aperture time-of-flight counter system, 18: 33972
WARD, C., Survey of 60° beam at Princeton-Pennsylvania accelerator, 18: 34380
WARD, S. H., Effect of shock on susceptibility of magnetite grout mixture, 18: 34284 (UCRL-13088)
WARFIELD, George, Prog. rpt. on lattice and electronic defects in solids, final, 6/64, 18: 34280 (NYO-2680-1)
WARKE, Chindhu S., Shape independence of low-lying states of nuclei, 18: 34906
WARNER, Philip Cloudesley, Improvements in block structures, 18: 35096
WARREN, I. H., Thermoelectric properties of cubic U monocompounds, 18: 34142
WARREN, Shields, Pathology of ionizing radiation, 18: 33396
WASLEY, Richard J., Design and construction of new coaxial electrical discharge pin, 18: 33862
WASSERBURG, G. J., Isotopic and cosmic chemistry, 18: 33456
WASSERBURG, G. J. F., Redistribution of Sr and Rb isotopes during metamorphism, 18: 33793
WATANABE, Kenju, Extraction of Cm and Am by tri-n-octyl phosphine oxide, 18: 33686
WATANABE, Shigueo, Doublet splittings in Y-90, 18: 34870
WATANABE, T., Fission cross section of Pu-241, 18: 34914
WATARI, Wataro, Nucleon-nucleon potential in the triplet-even state, 18: 34931
WATKINS, G. D., New O infrared bands in annealed irradiated Si, 18: 34239
WATSON, Charles, Nuclear reaction $Y^{89}(d,p)Y^{90}$, 18: 34834
WATSON, Eric, Improvements relating to reactor fuel assemblies, 18: 35132
WATSON, R. E., Quadrupole antishielding factors for rare-earth ions, 18: 34442
WATSON-MUNRO, C. N., Velocity of hydromagnetic ionizing fronts in cylindrical geometry, 18: 35009
WATTS, F. Clay, Incorporation of unbound iodide-131 into non-radioactive hippuran molecule, 18: 33646
WAWRZYCZEK, Wiktor, Titration of rare earths with Na_2WO_4 solution, 18: 33510
WAWRZYCZEK, Wiktor, Volumetric determination of Gd, 18: 33481
WEAVER, C. F., Hydrogen–deuterium kinetic-isotope effect, 18: 33573
WEAVER, C. F., Phase equilibria in $NaF–BeF_2–ThF_4$ system, 18: 33582
WEAVER, Lynn E., Improvement of BWR stability through minimization of boiling noise, 18: 35062 (EURAEC-1138)
WEBB, John, Reactors cooled by liquid metal, 18: 35122
WEBBER, W. R., Intensity and modulation of low-rigidity cosmic rays, 18: 34477
WEBER, James, Prog. rpt. on steam separation technology, 4–6/64, 18: 33693 (ACNP-64026)
WEBSTER, C. C., Water-loss test at the LITR, 18: 35222 (ORNL-TM-632)
WEBSTER, Medford S., High-energy separated beam for 80-in. chamber, 18: 34365 (BNL-8145)
WEDGWOOD, F. A., Magnetic ordering in heavy rare earth metals, 18: 34188
WEHMANN, U., g-Factor of 248 kev state of Se-77, 18: 34895
WEHNER, G. K., Darkening of powdered basalt by simulated solar-wind bombardment, 18: 34392
WEHRLI, H., Photochemical rearrangement of steroids, 18: 33635
WEIDENBAUM, B., Prog. rpt. on high-performance UO_2 program, 4–6/64, 18: 35127 (GEAP-3771-13)
WEIDENBAUM, B., Uranium dioxide thermal conductivity from irradiations with central melting, 18: 34215 (GEAP-4624)
WEIDENMUELLER, H. A., Theory of low-energy nuclear reactions, 18: 34754 (HMI-B-35)
WEIDNER, L. J., Jr., Nuclear fuel scheduling for Malibu nuclear plant, 18: 35187
WEIGMANN, H., K ionization through electron and positron ions, 18: 34431
WEIK, H., Effect of lattice orientation on channeling of fast neutrons through $SrTiO_3$ single crystals, 18: 34246
WEIL, Louis, Thermal conductivity and thermoelectric force of U–Mo, 18: 34143
WEINBERG, Leo H., Selector for fast and intermediate neutrons, 18: 33980
WEINBERG, Steven, Photons and gravitons in S-matrix theory, 18: 34658
WEINER, H., Electrostatic separators for a zero-gravity environment, 18: 33701
WEIR, J. R., In-reactor stress-rupture properties of 20 Cr–25 Ni, 18: 34218 (ORNL-TM-881)
WEISBERG, H. L., Single-valued time-to-pulse-height system, 18: 33931
WEISE, Lothar, Statistics of nuclear particle counting and pulse spectrometry, 18: 33964
WEISGERBER, P., Passivating oxide layers on Zr, 18: 34063
WEISMANTEL, E. E., Brazing Be metal, 18: 34110
WEISMANTEL, E. E., Welding of heavy Be–Cu plates, 18: 34111
WEISS, S. B., Enzymatic synthesis of RNA. I., 18: 33243
WEISS, S. B., Enzymatic synthesis of RNA. II., 18: 33244
WEISS, S. B., Enzymatic synthesis of RNA. III., 18: 33245
WEISSGLAS, P., Microwave emission from cylindrical plasma, 18: 34986
WEISZ, Herbert, Recent developments in the ring-oven technique, 18: 33497
WEISZ, Paul B., Advances in catalysis. XIV., 18: 33453
WEITZENMILLER, F., Two- and many-component systems with Pu. II., 18: 34125 (KFK-220)
WELLER, C. S., Recombination of molecular positive ions with electrons, 18: 34259 (AD-434907)
WELLER, F. H., Calculation of Te and I fission-product activities, 18: 35228
WELLER, P. F., Doping of alkaline earth halide single crystals, 18: 34159
WELLS, Molly, Superconductivity in metal carbides, 18: 34684 (UCRL-11368)
WELLS, William M., Silicon nitride as high-temperature radome material, 18: 34054 (UCRL-7795)
WENDT, G., Detailed forms of yield curves from semi-thick Al targets, 18: 34917
WENKOFF, M. P., Photoelectric scanning system for auroral height measurements, 18: 34674
WENTWORTH, R. C., Sub-ELF geomagnetic fluctuations. II., 18: 34670 (AD-437330)
WENTZ, L. B., Prog. rpt. on kinetic studies of heterogeneous water reactors, annual, 1963, 18: 35068 (STL-6312)
WENTZ, L. B., Prog. rpt. on kinetic studies of heterogeneous water reactors, 6/64, 18: 35223 (STL-372-6)
WENZEL, P., Thermal reactors with Pu recycling, 18: 35168
WERNICK, J. H., Paramagnetic resonance of S-state ions in metals, 18: 33587
WERT, C., Solubility of N in Ta, 18: 33595
WESTER, P. O., Neutron activation analysis for trace elements in heart tissue, 18: 33457 (AE-146)
WESTGREN, R. C., Dispersion-strengthened refractory alloys, 18: 34197
WESTON, L. W., Ratio of capture-to-fission in U-235, 18: 34886
WETZEL, Lewis, Far-flow approximations for precursor ionization profiles, 18: 34288
WHARTON, C. B., Collisionless damping of electrostatic plasma waves, 18: 35016
WHEAT, J. Allen, Determination of metallic impurities in H_2O by atomic absorption spectrometry, 18: 33461 (DP-879)
WHEATLEY, J. C., Thermal boundary resistance between solids and He below 1°K, 18: 34697
WHELPLEY, W. A., Injun I observations during latter September-early October, 1961, 18: 34493
WHIFFEN, D. H., Dipole moment of linear XYX' molecules, 18: 33597
WHIPPMAN, M. L., Equivalence of elementary and composite particles, 18: 34522
WHITE, E. A. D., Study of trivalent-pentavalent oxide systems, 18: 34199
WHITE, Helen W., Report number series, 18: 35251 (TID-85(3rd Rev.))
WHITE, J. L., Prog. rpt. on reactor materials, 10/62–9/63, 18: 34122 (GA-4900)
WHITING, Allen R., Prog. rpt. on Elk River reactor pressure vessel, 4–5/64, 18: 35154 (SWRI-1228-28)
WHITNEY, J. B., Applying protective coatings to Nb alloys, 18: 34052 (RTD-TDR-63-4063)

WHITSON, A. L., Variation of potential gradient with altitude, 18: 33773
WHITTAKER, A. Greenville, Surface temperature measurements on burning solids, 18: 33581
WIDEMANN, Francois, Electron spectrum of W-187 transmutation, 18: 34804
WIEN, K., Decay of 23.5-min U-239, 18: 34850
WILCKE, O., Brain-tumor diagnostics with positron radiation, 18: 33432
WILDERMUTH, K., Cluster model of nuclear fission. I., 18: 34872
WILETS, L., Finite superconductors and their infinite volume limit, 18: 34703
WILHELM, Harley A., Phase equilibria and crystallography for Nb–Sn, 18: 34165
WILHELMSSON, K. H. B., Dynamic wave propagation in ionized media. XI., 18: 34967 (AFCRL-63-786)
WILIP, Elmer K., Instability-loop of AEG-etomic power laboratory, 18: 35090 (ANL-Trans-52)
WILIP, Elmer K., MHD impact flow-tube problem proposal, 18: 35166 (ANL-Trans-38)
WILKIE, W. H., Positron flux in infinite Cu medium containing Cu-64, 18: 34904
WILKS, R. S., Effect of irradiation on microstructure of hot-pressed BeO, 18: 34225
WILLAIN, C., Exchange contribution to elastic scattering of α particles, 18: 34801
WILLARD, H. B., Nuclear resonance and Coulomb excitation in $Na^{23}(p,p')$ reaction, 18: 34836
WILLI, A. V., Kinetic isotope effects for some CH_3I nucleophilic substitutions, 18: 33612 (BNL-8066)
WILLI, A. V., Solvation of charge groups in organic compounds, 18: 33613
WILLIAMS, C. W., Time-of-flight measurements of fission fragments with semiconductor detectors, 18: 33955
WILLIAMS, E. M., Diffusion and drift of positive ions in Ne, 18: 34449
WILLIAMS, H. J., Paramagnetic resonance of S-state ions in metals, 18: 33587
WILLIAMS, Ronald Peter, Nuclear reactor, 18: 35217
WILSON, Everett D., Whole-body retention of I-131 in box turtles, 18: 33254
WILSON, John, Prog. rpt. on steam separation technology, 4–6/64, 18: 33693 (ACNP-64026)
WILSON, M. N., Insulation for 11-kv 280-kg pulsed magnet, 18: 33717
WILSON, Richard, Electroproduction of protons at 1 and 4 Bev, 18: 34916
WINCH, D. E., Quiet-day solar daily magnetic variations, 18: 34387
WINDUS, Walter Bristol, Radiation effects on Weston Cd cell, 18: 34217 (NP-14183)
WISE, C. E., Atomic power. I. Central power stations, 18: 35180
WISE, C. E., Reactors for propulsion, 18: 35205
WISNIEWSKI, Wieslaw, Titration of rare earths with Na_2WO_4 solution, 18: 33510
WITTE, John C., Low-temperature dynamic nuclear polarization, 18: 34717
WITTERN, H., Refined cluster wave functions for Li-6, 18: 34631
WITTKOWER, A. B., Production of intense negative He and H ion beams, 18: 34381
WITZIG, Warren F., Nuclear power today and tomorrow, 18: 35178
WLODEK, S. T., Corrosion resistance of refractory metals, 18: 34084
WOJCIECHOWSKI, H., Elastic scattering of 24.7-Mev α particles, 18: 34902
WOLF, J., Preparation of active UO_2, 18: 33533 (UJV-725/63)
WOLFF, Sheldon, Chromosome splitting, 18: 33318
WOLFGANG, Richard, Hot H displacement reaction with isobutane, 18: 33640
WOLFSBERG, Max, Kinetic isotope effects for some CH_3I nucleophilic substitutions, 18: 33612 (BNL-8066)
WOLFSON, J. L., Gamma transitions in Np-237, 18: 34802
WONG, C., Neutron spectra from the (p,n) reaction, 18: 34859
WONG, David Y., Meson resonances and N-N potentials, 18: 34539
WONG, Howard, Thermal equilibration of shock-heated plasma, 18: 35042
WONG, J., Consolidation of refractory metals, 18: 34102
WONG, K. W., Excitation spectrum in liquid He II, 18: 34702
WONG, Morton Min, Electrorefining Be, 18: 34031 (BM-RI-6489)
WOOD, A., Carbon isotope effects in decarboxylation of oxaloacetic acid. I., 18: 33598
WOOD, Herbert T., Quantum corrections to the transport cross sections, 18: 34650
WOOD, Lowell, Radiocarbon date discrepancies, 18: 33789
WOODARD, Helen Q., Prog. rpt. on effects of x rays on mice bones, 5/63–5/64, 18: 33276 (NYO-910-7)
WOODLEY, R. E., Reaction of nuclear graphite with CO_2, 18: 33525 (HW-74663)
WOODROW, R. J., Prog. rpt. on lattice and electronic defects in solids, final, 6/64, 18: 34280 (NYO-2680-1)
WOODRUFF, E. M., Dimensional changes in large graphite bars, 18: 34231
WOODWARD, William J., Electronic trip device, 18: 33826 (DP-897)
WOODWELL, G. M., Carbon dioxide exchange by *Pinus rigida* trees exposed to irradiation, 18: 33315
WOOLLASTON, H. J., Effect of irradiation on microstructure of hot-pressed BeO, 18: 34225
WORK, G. A., Design and performance of ion engine systems, 18: 33699
WORLOCK, R. M., Electron bombardment and contact ion engines, 18: 33698
WRIGHT, Hervel, Interaction of a plasma with a "helical" electron beam, 18: 35011
WRIGHT, J. K., Electrical breakdown of gases by intense pulses of light, 18: 34350
WRIGHT, K. A., Fluorescence from light and medium-weight nuclei, 18: 34852
WRIGHT, R. W., Prog. rpt. on kinetic studies of heterogeneous water reactors, annual, 1963, 18: 35068 (STL-6312)
WUSCHKE, E. E., Automatic sample changer for α-, β-, and γ-active sources, 18: 33716
WYATT, A. F. G., Density of electron states in superconducting Ta, 18: 34708
WYATT, L. M., Aluminum and Mg in reactors. II., 18: 34176
WYLLER, Arne A., Collision effects in hydromagneto-ionic theory, 18: 35038

X

XUONG, Nguyen-huu, ρ Exchange mechanism in reaction $\pi^+ + p \rightarrow N_{33}^{3,3++} + \pi^0$, 18: 34626
XUONG, Nguyen-huu, T = 2 pion-pion interaction, 18: 34630

Y

YACHNIN, S., Biologic properties of polynucleotides. I., 18: 33222
YACHNIN, S., Interaction between bovine serum albumin and polyribonucleotides. III., 18: 33247
YAGER, Philip M., T = 2 pion-pion interaction, 18: 34630
YAGI, Kohsuke, Numerical differential cross sections of $Ca^{48}(p,d)Ca^{39}$ at 55 Mev, 18: 34757 (INSJ-72)
YAGOVDIK, M. Z., Trace elements in radiation dermatitis, 18: 33285 (JPRS-25502)
YALOW, A. Aaron, Kinetics of K-42 distribution in human subjects, 18: 33238
YAMABE, S., Polarization of 40-Mev protons, 18: 34550
YAMADA, Masao, Origin of pseudoscalar boson mass, 18: 34608
YAMAGATA, N., Assessment of the total body burden of Cs-137, 18: 33263
YAMAMOTO, S. S., Decay modes and properties of the X^0, 18: 34592
YAMATERA, Hideo, Determination of H in D_2O, 18: 33539
YAMAZAKI, Miwao, N/D formalism for scattering amplitudes, 18: 34605
YANT, Howard, Prog. rpt. on steam separation technology, 4–6/64, 18: 33693 (ACNP-64026)
YANUSHKOVSKII, V. A., Control device for using modulated radioactive radiation, 18: 33843 (AEC-tr-6399(p.1-9))
YANUSHKOVSKII, V. A., Radioactive instruments for automatization in chemical industry, 18: 33990 (AEC-tr-6399(p.258-76))
YANUSHKOVSKII, V. A., Sources of x rays with Sr-90–Y-90 as base, 18: 33989 (AEC-tr-6399(p.243-57))
YARMONENKO, S. P., Central M-choline reactive systems of irradiated mice, 18: 33368
YASUNO, Takehiko, Prompt neutron lifetime in a reflected system, 18: 35116
YATES, G. Kenneth, Solar flare high-energy α particles and storage in space, 18: 34389
YAZDOVSKII, V. I., Biological action of cosmic radiation in flights, 18: 33354
YEFIMOV, N. N., Temporal variations of different components of cosmic rays, 18: 34463 (NASA-TT-F-126(p.81-101))
YEFIMOV, N. N., Temporal distribution of extensive air showers of cosmic rays, 18: 34475 (NASA-TT-F-126(p.292-4))
YEH, C., Diffraction of EM waves by arbitrarily shaped dielectric obstacles, 18: 34346
YERICK, R. E., Liquid scintillator for thermal neutron detector, 18: 33953
YEVICK, George J., Prog. rpt. on cusped containment geometries, annual, 1963–64, 18: 34978 (SIT-P126)
YIFTAH, S., Nuclear power program in small countries, 18: 35148 (IA-891)
YIFTAH, S., Nuclear education and training at Israel Research Reactor, 18: 35219 (IA-894)
YIFTAH, S., Reactor physics research at Israel Research Reactor, 18: 35218 (IA-892)
YIP, Sidney, Time-dependent density correlations in fluids, 18: 34347
YNTEMA, Jan L., Radiation damage effects in Li-drifted Si detectors, 18: 33913

YOCOM, P. N., Rare earth–alkaline earth halide systems, 18: 33571
YOCOM, P. Niel, Color centers of alkaline-earth halides, 18: 33643
YODH, G. B., "U-spin equalities" and octet symmetry breaking, 18: 34586
YOKOTA, Mitsuo, The void and hole effect in D_2O-moderated reactor, 18: 35083
YOO, E. H., Diagnosis and treatment of cancer with radioactive isotopes. I., 18: 33438
YORK, C., Large aperture time-of-flight counter system, 18: 33972
YORK, C., Survey of 60° beam at Princeton-Pennsylvania accelerator, 18: 34380
YOSHIKAWA, H. H., In-pile dosimetry techniques, 18: 33879 (HW-SA-3585)
YOSHIKAWA, H. H., Radiation effects on pyrolytic graphite, 18: 34232
YOUNG, C. E., Hydrogen–deuterium kinetic-isotope effect, 18: 33573
YOUNG, James A., Neutron scattering by H_2O, 18: 34739
YOUNG, W. J. S. Y., Effect of tensor force on energy spectra of N-14 and F-18, 18: 34838
YU, C. K., Polyploidy induced by x rays in Chinese hamster cells *in vitro*, 18: 33383
YUDINTSEVA, E. V., Accumulation of Sr-90 in crops, 18: 33241
YUKHLOV, A. K., Changes in sorption properties of brain and kidney tissues after doses of U-235 fission products, 18: 33358
YUWILER, Arthur, Intrascintillation vial reaction tube, 18: 33478

Z

ZAGORCIC-JANKOVIC, A., Radiation contamination of animal foods, 18: 33255
ZAKHAROVA, K. P., Sources of x rays with Sr-90–Y-90 as base, 18: 33989 (AEC-tr-6299(p.243-57))
ZAKI, M. R., Co-precipitation of uranyl ion with Zr hypodiphosphate, 18: 33600
ZARTMAN, R. E., Ancient granite gneiss in Black Hills, 18: 33768
ZAUDERER, Bert, Impurity effects on ionization rate in Xe shock waves, 18: 34361
ZAVATTINI, E., Resonance in the dipion mass region 280 to 350 Mev, 18: 34552
ZAWISCHA, D., Superfluidity in Fermi systems, 18: 34864
ZAYTSEV, K. K., Transplantation of bone marrow in radiation sickness, 18: 33403
ZDANSKY, K., Resonance of F center in x-irradiated F^{19}-doped BeO, 18: 33657
ZEMANOVA, L., Radiosensitive factors of cellular proliferation, 18: 33307
ZERBI, Giuseppe, Low-frequency vibrations of crystalline biphenyl, 18: 34302
ZHUKOV, M. V., Change in cardio-vascular system in rabbits chronically irradiated, 18: 33364
ZHULANOVA, Z. I., Change in composition of liver lipid of irradiated animals, 18: 33360
ZICHA, B., Effect of x irradiation *in vitro* on formation of oxidation products of lipids, 18: 33305
ZIEGLER-NARAY, Maria, Hydrodynamical model of wave mechanics. II., 18: 34638
ZIESCHE, P., General properties of electron gases, 18: 34644
ZINOV, V. G., Transition of μ^- mesons from proton to C, 18: 34947
ZIOCK, K., Proposed orbiting x-ray telescope, 18: 33970
ZIVADINOVIC, Milutin S., Neutron diffractometer, 18: 33881 (NP-14131)
ZIVI, S. M., Prog. rpt. on kinetic studies of heterogeneous water reactors, 1–3/64, 18: 35067 (STL-372-3)
ZIVI, S. M., Prog. rpt. on kinetic studies of heterogeneous water reactors, annual, 1963, 18: 35068 (STL-6312)
ZIVI, S. M., Prog. rpt. on kinetic studies of heterogeneous water reactors, 6/64, 18: 35223 (STL-372-6)
ZLATANOV, Z. M., Elastic scattering of 6.2-Bev protons on deuterons, 18: 34616
ZOLLER, L. K., Fast neutron removal cross sections, 18: 34888
ZORN, G. T., Magnitude of the K_1^0–K_2^0 mass difference, 18: 34593
ZUMWALT, Lloyd R., Fuel element, 18: 35136
ZUPAN, J., Applying protective coatings to Nb alloys, 18: 34052 (RTD-TDR-63-4063)
ZURMUHLE, R. W., Levels in Sc-42 from $Ca^{40}(He^3,p)Sc^{42}$, 18: 34960
ZWEIG, G., SU_3 model for strong interaction symmetry and its breaking. II., 18: 34510 (NP-14146)
ZYRYANOVA, L. N., Once-forbidden β transitions, 18: 34957

SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is indentifiable by the absence of a report number.

General Indexing Style

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair. However, the information would not be indexed under the experimental animal, e.g., Rats, unless the report discusses the effects on rat hair as compared with the effect on the hair of other animals.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium — isotopes He-4 or Helium — He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid — methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly with cross references under the element components. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

In this subject index specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract than would be possible with only a word or two whenever it appears that such information would be useful. Such phrases are written so that the idea considered most important is presented first, should a not-too-awkward expression result. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium — allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

A

ABRASIVES
hardness and physical properties of grinding wheel, 18: 34095
ACCELERATORS
neutron dosimetry near, using double-moderator detector, 18: 33951
plasma, surface effects in pulsed, 18: 34980
storage ring development for, 18: 34271(R) (LAL-1107)
storage ring operations for electrons, 18: 34370 (LAL-1110)
use of nanosecond-pulse electron, for semiconductor detector transient response analysis, 18: 33919
ACETAMIDE
analysis for active hydrogen by NMR spectroscopy, 18: 33475
ACETIC ACID
solvation of charge groups in, substituent effects on chemical equilibria and rate in, 18: 33613
ACETIC ACID, [(CARBOXYMETHYLIMINO) BIS(ETHYLENENITRILO)] TETRA-
effects on cerium-144 removal in mice, 18: 33417
ACETIC ACID, (1,2-CYCLOHEXYLENEDINITRILO) TETRA-
analytical use for potentiometric determination of mercury and other metals alone and in mixtures, 18: 33507
ACETIC ACID, (ETHYLENEDIAMINE) TETRA-
effects on lead absorption and excretion in rats, 18: 33249
labeling with cobalt-57, radiodiagnosis using, 18: 33231(R) (NIRS-2(p.49-56))
ACETIC ACID, (PHENYLENEDIOXY)DI-
ion exchange properties for zirconium in metal solutions, 18: 33508
ACETONE
analysis for active hydrogen by NMR spectroscopy, 18: 33475
effects on radioinduced polymerization modification of acrylonitrile, 18: 33650
ACETONE, THENOYLTRIFLUORO-
complexes with europium, quenching and temperature dependence of fluorescence in, 18: 33556
ACETONITRILE
effects on radioinduced polymerization modification of acrylonitrile, 18: 33650
nitrogen-14 NQR in, relaxation of, 18: 33615
ACETYLENE
ionization of, appearance potential measurements on secondary ions produced by, 18: 33569
ACOUSTIC WAVES
interactions with hydromagnetic waves at plasma-gas interface, 18: 35004
ACRYLIC ACID
radioinduced polymerization of menthol esters of, mechanism of polymerization of, 18: 33674
ACRYLIC ACID, ALLYL ESTERS
effects on radioinduced crosslinking of polyisobutylene, 18: 33652
ACRYLONITRILE POLYMERS
radioinduced formation of modified, in acetone and other solvents, 18: 33650
ACRYLONITRILES
radioinduced polymerization modification in acetone and other solvents, 18: 33650
radioinduced polymerization with methyl furan, infrared spectra of products in, 18: 33670
ACTINIUM ISOTOPES Ac-227
separation from radium and thorium-227 by ion exchange, 18: 35246(R) (MLM-1196)
ACTIVATION ANALYSIS
design of automated instrumental system for analysis of biological materials, 18: 33464 (NASA-CR-52997)
neutron reactions in, parameters for interfering, 18: 33492
of trace elements in normal and leukemic leukocytes, 18: 33517
radioactivity in, nomographs for determining, 18: 34012
ADENOSINE
developmental effects on sea urchin, 18: 33270(R) (NIRS-2(p.23-6))
ADHESIVES
preparation and properties of conductive polyurethane-base, 18: 35246(R) (MLM-1196)
radiation effects on, handbook on, 18: 34245
radiation effects on structural, at low temperatures, 18: 34247
ADIPIC ACID
radioinduced free radicals in diethyl ester of, ESR spectra and molecular motion of, 18: 33641
ADRENAL GLANDS
radiation effects on histology of fish, x, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on cortical function in rat, x, 18: 33272(R) (NIRS-2 (p.31-42))
radiation effects on absorption in rat, gamma, 18: 33357
radiation effects on mouse, gamma, 18: 33367
ADRENALINE
radiation effects on secretion of, in rats, 18: 33277 (STI/DOC/10/28 (p.21-38))
ADRENOCORTICOTROPIC HORMONE
effects on phosphatide content and metabolism in irradiated and normal rat testes, 18: 33256
protective effects of, against radiation injuries in rats, 18: 33411
ADVANCED TEST REACTOR
fuel plate fabrication procedures, 18: 34087 (ORNL-3644)
AEROSOLS
formation and properties of particle, review on, 18: 33823
particle dispersion in atmospheric, 18: 33806(R) (NYO-10715)
sorptive properties for radioiodine, 18: 33805(R) (NIRS-2(p.57-67))
AGE ESTIMATION
oxygen-16/18 analysis of mollusk fossil shells, 18: 33784
radiocarbon dating, accuracy of, 18: 33789
AGRICULTURE
civilian defense measures for, 18: 33814
potato separation from ground lumps, use of gamma rays in automatic, 18: 33991(T) (AEC-tr-6399(p.277-85))
radiation effects on hydroponic, gamma, 18: 33997
AIR
analysis for methane using kryptonates, 18: 33450(R) (NYO-2757-4)
charge exchange by argon and xenon ions in, cross sections for, 18: 34409
gamma dose spatial distribution in, 0.05- to 10-Mev scattered, 18: 33810
radon content near ground in, beta counting method for determining, 18: 34257
separation from water, development of centrifugal separators for, 18: 33693(R) (ACNP-64026)
separation of iodine-131 from, by activated charcoal, 18: 33808(T) (AEC-tr-6459)
separation of plutonium hexafluoride from, in exhaust systems, 18: 33678(R) (ANL-6875)
ALANINE, PHENYL-
uptake by uv-irradiated polyuridylic acid, chemical and photoreactivation effects on, 18: 33392
ALASKA
strontium exchange in soil of, factors affecting, 18: 33777
ALBUMINS
binding of cations by bovine serum, covering emulsions, 18: 33575
chromatographic separation of peptides from ovalbumin, 18: 33499
effects of lipidic peroxides on thiol groups in, 18: 33236(T) (ANL-Trans-54)
radiation and burn injury effects on content of, in rats, 18: 33381
reactions of blood serum, with polyribonucleotides, 18: 33247
tracer uses of iodine-131-labeled, for edema, 18: 33231(R) (NIRS-2 (p.49-56))
ALGAE
fission product metabolism by, 18: 35238 (STI/DOC/10/28(p.9-20))
growth and nitrogen fixation by Nostoc, effects of calcium, cobalt, molybdenum, and strontium on, 18: 33237
radioisotope uptake by, 18: 33230
uranium metabolism by, 18: 35238 (STI/DOC/10/28(p.9-20))
ALKALI METAL HALIDES
thermodynamic properties at melting point, 18: 35247(R) (NAA-SR-9700)
ALKALI METALS
compound formation in mixtures with alkaline earth metals, 18: 34131 (TID-20849)
ALKALINE EARTH FLUORIDES
rare earth ions in, chemical conversion of trivalent to stable divalent, 18: 33571
ALKALINE EARTH HALIDES
preparation of doped, single crystals of, 18: 34159
rare earth ion reduction in, electrolytic, 18: 33589
ALKALINE EARTH METALS
compound formation in mixtures with alkali metals, 18: 34131 (TID-20849)
ALLOYS
dimensional instability, review, 18: 34121 (DMIC-Memo-189)
separation of cerium from heat conducting, by precipitation using hydrofluoric acid, 18: 33504
ALPHA PARTICLES
detection at high temperatures, silicon carbide detector for, 18: 33918
detection by semiconductor detectors, response for, 18: 33916
detection of, low-background scintillation counter for, 18: 33933
detection using alkali halide crystals, scintillation efficiencies for, 18: 33636
effects on absorption spectra, electron emission, and luminescence of lithium fluoride crystals, 18: 33632
emission in curium-244 spontaneous ternary fission, energy spectra of,

18: 34955
reactions (α,γ) with silicon-28, 18: 34924
reactions (α,γ) with oxygen-16 at 4.8 to 9.9 Mev, 18: 34829
reactions (α,d) with nuclei at 45 to 50 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
reactions (α,n) with bismuth-209 at 15 to 26 Mev, differential cross sections for, 18: 34777 (UCRL-11238)
reactions (α,p) with nuclei, diffraction mechanism for direct, 18: 34848
reactions in nuclear emulsion, radii for, 18: 34964
reactions with lithium-drifted silicon detectors, damage effects in, 18: 33913
reactions with plastic scintillators-scintillation output from, 18: 33638
reactions with thin foils, secondary electron emission from, 18: 33911
scattering by carbon-12 at 5 to 60 Mev, crossover technique for energy determination in, 18: 34934
scattering by light nuclei, exchange contribution to elastic, 18: 34801
scattering by nuclei, multiparametric modular circuitry for detection of, 18: 33936
scattering by nuclei at 24.7 Mev, relative cross sections for elastic, 18: 34902
scattering by nuclei, diffraction mechanism for elastic, 18: 34848
therapeutic use of, from boron-10 neutron capture, 18: 33431 (TID-20856)

ALPHA SOURCES
counting of, automatic sample changer for, 18: 33716
measurement method for, 18: 33819
preparation of, microcolumn technique for, 18: 33654
thickness of, selection of optimal, 18: 33894
use in gas pressure gages, 18: 33874(P)
use in vacuum gages, 18: 33999

ALPHA SPECTROMETERS
design, 18: 33819
source thickness for, selection of optimal, 18: 33894

ALTIMETERS
design of, using alpha particle attenuation, 18: 33874(P)

ALUMINUM
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
alpha reactions with, secondary electron emission from, 18: 33911
beta scattering by, measurement of saturation backscattering from, 18: 35057
bonding by solid-state pressure, 18: 34032(R) (BMI-1668(Del.))
cavitation by liquid sodium, 18: 34075 (NASA-CR-54071)
compatibility with beryllium–thorium–uranium alloy, 18: 34033(R) (BMI-1669(Del.))
compatibility with uranium nitride at 500 and 600°C, 18: 34035(R) (BMI-X-10053)
contents in meteorites, 18: 34398
corrosion by alum in cooling water treatment in Hanford F Reactor, 18: 35193 (HW-78431)
corrosion by coolant in D reactor, effects of pH on, 18: 35194 (HW-78964)
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
electron attenuation, 18: 33886(T) (JPRS-25467(p.9-24))
electron reactions at 10 and 20 Mev, bremsstrahlung from, 18: 34459
electron reactions at 1 and 4 Bev, proton production in, 18: 34916
electron scattering by, electron–positron pairs from, 18: 34258(R) (AD-417250)
electron scattering by, energy loss mechanisms in relativistic, 18: 34258(R) (AD-417250)
gamma coherent scattering at small angles, 18: 35053
heat transfer across contacting surface with iron, 18: 33735 (MIT-2079-2)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
oxygen-16 reactions at 167 Mev, charged-particle emission in, 18: 34780 (UCRL-11349)
performance as dopant in lithium-drifted silicon junctions, ion-pairing in, 18: 33922
performance in cryogenic 95-kOe magnets, 18: 34682(R) (NBS-8407)
polarization in aqueous sulfate solutions, electrochemistry of passivating oxide film formed in, 18: 34063
properties as diffusion barrier for refractory metals, 18: 34029(R) (AD-601740)
properties as recoil attenuator for oxygen-16 reactions with bismuth, iridium, and lead-208 at 76 to 165 Mev, 18: 34782 (UCRL-11563)
proton reactions (p,γ) with, yield curves for, 18: 34917
proton scattering at 75 to 184 kev, angular distributions for, 18: 34943
radiation effects on mechanical properties of 1100, fast neutron, 18: 34032(R) (BMI-1668(Del.))
radiation effects on mechanical properties of 1100, fast neutron, 18: 34033(R) (BMI-1669(Del.))
radiation effects of neutrons on electric conductivity of, annealing of, 18: 34222
reactions with steam, reactor safety studies of, 18: 33678(R) (ANL-6875)
reactions with water and steam, 18: 35060(R) (ANL-6904)
separation from zirconium ion exchange on pyrocatechol-*O,O*-diacetic acid, 18: 33508
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
sorptive properties for young fission products from solutions, 18: 33448 (IDO-14644)
welding of, characteristics of electron beam, 18: 34112

ALUMINUM ALLOYS
analysis for zirconium, photometric, 18: 33512
corrosion by water under ATR conditions, 18: 34074 (IDO-24460)
properties as fuel element cladding in steam and water environments, 18: 34076 (TID-8540(p.213-330))
reactions with water and steam, 18: 35060(R) (ANL-6904)
Al–Be, characteristics of electron beam welding of, 18: 34112
Al–Ce, production and properties of, 18: 34099
Al–Mg, decomposition reactions of solid solutions of, effects of vacancies on, 18: 34135(T) (Al-Trans-53)
Al–Mg, radiation effects on aging and resistivity of, 18: 34244
Al–Nb, radiation effects of neutrons on superconductivity of, 18: 34683(R) (NP-14136)
Al–Nb, superconducting transition of Nb_3Al, effects of vanadium on, 18: 34283 (UCRL-11390)
Al–Ni–U, reactions with steam, reactor safety studies of, 18: 33678(R) (ANL-6875)
Al–Sn, deposition on D-14 niobium alloy, 18: 34052 (RTD-TDR-63-4063)
Al–U, oxidation kinetics of intermetallic compounds in, 18: 34077
Al–U, properties as reactor fuel, 18: 34130 (TID-8540(p.331-410))
Al–Zn, beta scattering from, 18: 35057

ALUMINUM COUPLES
Al/Sn, superconductivity, 18: 34723

ALUMINUM ISOTOPES Al-26
positron spectra, 18: 34783(T) (ORNL-tr-235)

ALUMINUM ISOTOPES Al-27
argon-40 reactions at 270 Mev, production of scandium-44 isomer pairs in, 18: 34948
deuteron reactions (d,α) at 1.5 to 2.6 Mev, 18: 34823
proton reactions with, angular correlations in, 18: 34822

ALUMINUM OXIDES
development of coatings of, for fuel particles, 18: 34032(R) (BMI-1668 (Del.))
development of coatings of, for fuel particles, 18: 34033(R) (BMI-1669 (Del.))
effects on properties and sinterability of zirconium oxide, 18: 34155
electrochemistry of passivating films of, formed on metal by polarization, 18: 34063
permeation of membranes of, effects of stresses on, 18: 34056 (UCRL-11355)
properties as recoil attenuator for oxygen-16 reactions with bismuth, iridium, and lead-208 at 76 to 165 Mev, 18: 34782 (UCRL-11563)
Al_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Al_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199

ALUMINUM SYSTEMS
Al–C–Mo, superconducting transition of Mo_2Al_2C, 18: 34283 (UCRL-11390)
Al–C–Mo–Ni–Si–U–Zr, preparation and fabrication as refractory fuel material, 18: 34071(P)
Al–C–Nb, superconducting transitions in, 18: 34283 (UCRL-11390)
Al–Cr–Si, coating processes for cementation on refractory metals, 18: 34091

AMERICIUM
separation from ammonium nitrate solutions by solvent extraction using trioctylphosphine oxide, 18: 33686
separation from hydrochloric acid solutions by solvent extraction using trioctylphosphine oxide, 18: 33686

AMERICIUM COMPLEXES
with bromide and chloride in solutions, spectrophotometric and ion exchange studies, 18: 33526 (IA-924)

AMERICIUM IONS
spectra of, missing band in, 18: 33574

AMERICIUM ISOTOPES Am-241
alpha decay of, gamma recoilless emission after, 18: 34920
alpha decay rate, 18: 34813
determination in urine, 18: 33518
electrodeposition of 0.1 to 1 μC of, 18: 34005(R) (ORNL-TM-879)
properties for use as heat source in direct conversion devices, 18: 34002

AMERICIUM ISOTOPES Am-242
formation of spontaneously fissioning isomer of, in neutron reactions

with americium-243, 18: 34759 (JINR-D-1693)
AMERICIUM ISOTOPES Am-243
neutron reactions at 14 Mev, formation of spontaneously fissioning isomer in, 18: 34759 (JINR-D-1693)
AMIDE POLYMERS
radiation and thermal oxidation of, 18: 33668
radiolysis, 18: 33669
AMINES
effects of free, on morphology of erythrocytes, 18: 33277 (STI/DOC/10/28(p.21-38))
protective effects against radiation injuries in mice, 18: 33277 (STI/DOC/10/28(p.21-38))
AMINO ACIDS
lysozyme content of, effects of ultraviolet radiation on, 18: 33295
metabolism in rats, tracer study of, 18: 33213 (STI/DOC/10/28(p.79-103))
radiation effects on content in wheat sprouts, protective effects of magnesium sulfate, niacin, and thiamin against, 18: 33398
radiolysis of frozen aqueous solutions of, radical formation in, 18: 33675
AMMETERS
use of pico-, as trip device component in scram circuits, 18: 33826 (DP-897)
AMMONIA
heat transfer from plasma of, channel, 18: 33752
NH_3–He, electron temperatures in afterglow plasma of, 18: 34999
AMMONIUM COMPOUNDS, QUATERNARY
photochemical reactions of tetrabutylammonium iodide with uranyl nitrate, formation of tributylammonium iodide in, 18: 33628
AMMONIUM HYDROXIDES
reactions with (plutonium–uranium) nitrates, (plutonium–uranium) dioxides from, 18: 35146(R) (GEAP-4601)
AMMONIUM IODIDES
neutron scattering in, at 4 to 11 Å, 18: 34752(R) (CU(PNPL)-234)
AMMONIUM IONS
effects on chemical equilibria and rate of solvation of charge groups in aromatic compounds, 18: 33613
AMMONIUM NITRATES
surface temperature of catalyzed burning, measurements on, 18: 33581
NH_4NO_3–hydrazine nitrate, surface temperature measurements on catalyzed burning, 18: 33581
AMPLIFIERS
beam stability in d-c-pumped wave, 18: 34379
design and development of, summary, 18: 34752(R) (CU(PNPL)-234)
design of logarithmic, using planar transistors, 18: 33836 (RT/EL(64)-5)
design of low-noise, for semiconductor detectors, 18: 33898
design of pulse, using transistors, 18: 33861
development of low-noise charge-sensitive, for semiconductor detectors, 18: 33927
development of low-noise vacuum-tube, for semiconductor detectors, 18: 33928
radiation effects on magnetic control devices for, fast-neutron and gamma, 18: 33825 (AD-435095)
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
radiation effects on radiation-resistant, 18: 33869
ANALGESICS
effectiveness of novocain block in relief of pain from radiation injuries of rectum resulting from radium therapy of cervical carcinoma, 18: 33339
ANALYSIS
developments in ring oven technique, 18: 33497
ANEMIA
iron metabolism and erythrocyte life span in patients with congenital hemolytic, 18: 33214 (STI/DOC/10-28(p.105-11))
ANILINE
solvation of charge groups in, substituent effects on chemical equilibria and rate in, 18: 33613
ANILINE, N, N-DIMETHYL-
solvation of charge groups in, substituent effects on chemical equilibria and rate in, 18: 33613
ANIMAL CELLS
life cycle of, isotopic measurements on, 18: 33226
radiation effects on embryonic chick, gamma, 18: 33271(R) (NIRS-2(p.26-31))
radiation effects on nucleic acid structure of L-cells in tissue culture, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on, in culture, lethal, 18: 33278 (STI/DOC/10/28(p.39-66))
radiation effects on growth of, 18: 33307
radiation effects on sister chromatid exchange in chromosomes of hamster cells in culture, 18: 33329
radiation effects on vaginal, 18: 33348
radiation effects on giant formation in HeLa, protective effects of chemical substances against, 18: 33405
radiation injuries to, effects of uridine compounds on recovery from, 18: 33275(R) (NYO-910-2)
radiation recovery in, statistical model for, 18: 33355
radioinduced depletion of nucleated, in bone marrow, 18: 33351
radiosensitivity of cultured, effects of DNA content on, 18: 33278 (STI/DOC/10/28(p.39-66))
ANIMAL REPRODUCTION
effects of cerium-144 ingestion by pregnant rats on, 18: 33352
ANIMALS
radiosensitivity of tissues of, effects of oxygen concentration on, 18: 33404
radiosensitivity of adrenalectomized, effects of cortisone on, 18: 33404
ANION EXCHANGE MATERIALS
use of Dowex-1X4 for plutonium purification, accident during, 18: 33809(T) (HW-tr-78)
ANISOLE
fragmentation by electrons on deuterated and nondeuterated, mass spectra of, 18: 33627
ANISOLE, ETHYL-
dissociation of, appearance potentials and energies in electron, 18: 33627
ANISOLE, METHYL-
dissociation of, appearance potentials and energies in electron, 18: 33627
fragmentation by electrons on deuterated and nondeuterated, mass spectra of, 18: 33627
ANOXIA
effects on radiosensitivity of tumor cells in mice, 18: 33379
protective effects of, against radiation injuries in embryos of rats and mice, 18: 33423
radiosensitivity effects in young mice, 18: 33408
ANTENNAS
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation pattern distortion of plasma-covered horn terminated in ground plane, 18: 34968 (AFCRL-64-18)
receiving characteristics of two-wire, in uniform and nonuniform electric fields, 18: 35249 (SC-R-64-164)
ANTHRACENE
fluorescence decay time in deuterated and natural, device for measuring, 18: 33637
response to electrons at 0.6 to 1 Mev, 18: 33902
ANTIBIOTICS
effects on Artemia eggs, 18: 33271(R) (NIRS-2(p.26-31))
ANTIBODIES
localization of iodine-131-labeled, in tumors, 18: 33232(R) (NYO-910-3)
synthesis of, effects of treatment with native isologous nucleic acid on, 18: 33277 (STI/DOC/10/28(p.21-38))
ANTIGENS
radiation effects on synthesis of Forssman, x, 18: 33317
ANTIMONY
activation by thermal neutrons, self-shielding effects in, 18: 33488
content in human heart, neutron activation determination of, 18: 33457 (AE-146
determination by neutron activation, 18: 33483
determination in silicon, activation, 18: 33502
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
spectra of, x-ray L-absorption and -emission, 18: 34412
x-ray L-emission spectrum, 18: 34410
ANTIMONY ALLOYS
Sb–Cs–K, performance as photocathode, 18: 33903
Sb–In, radiation damage in, electron, 18: 34240
Sb–In–Sn, superconductivity in, 18: 34707
Sb–Nd, electric properties and uses of, 18: 34158
Sb–U, thermoelectric properties of cubic intermetallic compounds in, 18: 34142
ANTIMONY ISOTOPES Sb-121
energy levels, 18: 34882
ANTIMONY ISOTOPES Sb-122
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
ANTIMONY ISOTOPES Sb-124
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
ANTIMONY ISOTOPES Sb-125
gamma spectra of, least-squares analysis of, 18: 33926
ANTINEUTRINOS
interactions with electrons, spin correlations in, 18: 34614
interactions with deuterons and protons, scintillation detector for,

18: 33901
theory, 18: 34598
ANTIPROTONS
interactions with protons, statistical model for, 18: 34511(R) (NYO-2584-1)
APATITES
mineral content of, tracer study of, 18: 33277 (STI/DOC/10/28(p.21-38))
ARAGONITES
calcium/strontium ratio of skeletal, 18: 33259
ARGININE
radiosensitivity effects on Drosophila, gamma, 18: 33371
ARGON
analysis for trace gases in gas chromatography, electron drift velocity detector for, 18: 33476
cesium optical pumping in, spin relaxation time in, 18: 33566
crystal stability of, three-body interactions in, 18: 34706
electron drift velocity in, gas chromatography detector for, 18: 33476
heat transfer from plasma of, channel, 18: 33752
ion mobilities in liquid, positive, 18: 34343
ionization by normal shock waves, 18: 35042
ionization of, appearance potential measurements on secondary ions produced by, 18: 33569
molecular friction constant in liquid, use of isotope separation data for calculation of, 18: 34308
positron annihilation in, 18: 34752(R) (CU(PNPL)-234)
potassium scattering at thermal energies, total cross sections for, 18: 34407 (UCRL-11071)
rare-gas-ion scattering at 80 kev by, energy losses from, 18: 34416
reactions with inert-gas atoms, van der Waals forces for, 18: 34345
scattering of atomic beams of, by gold films, 18: 34420
separation from nitrogen by gettering on hot titanium sponge, 18: 33678(R) (ANL-6875)
ARGON IONS
reactions with ethylene molecules at 200 and 400 kev, mass spectra of fragments from, 18: 34433
scattering by rare gases at 80 kev, energy losses from, 18: 34416
ARGON ISOTOPES
content in Renazzo chondrite, 18: 34390
separation by thermal diffusion, 18: 35246(R) (MLM-1196)
ARGON ISOTOPES Ar-36
proton resonance scattering, 18: 34791
separation by thermal diffusion, 18: 34007(R) (ORNL-TM-890)
ARGON ISOTOPES Ar-37
decay of, K-Auger group intensities from, 18: 34789
energy level density, 18: 34841
ARGON ISOTOPES Ar-38
separation by thermal diffusion, 18: 34005(R) (ORNL-TM-879)
ARGON ISOTOPES Ar-40
alpha reactions (α,d) at 45 to 50 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
energy levels of, supermultiplet and unitary symmetries classification in collective model for, 18: 34897
reactions (Ar-40, Ar-41) with gold-197, angular distributions in, 18: 34763 (JINR-P-1675)
reactions (Ar-40, Cl-39) with gold-197, angular distributions in, 18: 34763 (JINR-P-1675)
reactions with aluminum-27 at 270 Mev, production of scandium-44 isomer pairs in, 18: 34948
ARGON SYSTEMS
Ar–methane, specific ionization by curium-244 and uranium-235 fission fragments, 18: 33895
ARGONNE ADVANCED RESEARCH REACTOR
development, May 1964, 18: 35060(R) (ANL-6904)
ARGONNE FAST REACTOR EXPERIMENT TEST
development, May 1964, 18: 35060(R) (ANL-6904)
ARMY REACTORS (SL-1)
power excursion of, extent of aluminum–water reaction in, 18: 33678(R) (ANL-6875)
ARSENIC
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination in silicon, activation, 18: 33502
gamma attenuation at 0.1 to 10 Mev, coefficients for, 18: 35058
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
neutron resonance absorption parameters of, 18: 34752(R) (CU(PNPL)-234)
ARSENIC ISOTOPES As-74
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
positron emission, diagnostic use of, after differential uptake by brain tumors, 18: 33432
ARSENIC ISOTOPES As-75
energy levels of, measurement of mean life of radioactive-decay-produced isomeric, 18: 34770 (NP-14115)
ARSENIC ISOTOPES As-76
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
ASTATINE
spectra of, absorption, 18: 33578
ASTATINE ISOTOPES
range-energy curves of 6- to 12-Mev recoils of, in aluminum and aluminum oxide foils, 18: 34782 (UCRL-11563)
ASTATINE ISOTOPES At-212
alpha decay of isomeric, 18: 34777 (UCRL-11238)
production of isomeric, in alpha reactions (α,n) with bismuth-209 at 15 to 26 Mev, 18: 34777 (UCRL-11238)
ASTROPHYSICS
element abundances in K-giant stars, 18: 34385
extragalactic origin of cosmic radiation, 18: 34486
massive condensations in interstellar matter and stellar associations, 18: 34394
ATHEROSCLEROSIS
radioinduced in rabbits and man, 18: 33277 (STI/DOC/10/28(p.21-38))
ATLANTIC OCEAN
geochronological and sedimentary profile, 18: 33790
ATMOSPHERE
aerosol behavior in, 18: 33806(R) (NYO-10715)
aerosol formation and properties in, review on, 18: 33823
bibliography on properties and phenomena in, 18: 34383(T) (NASA-TT-F-229)
contamination by cloud, measurement by sampling array, 18: 33803 (LA-3094)
contamination of ground-level, by radioactive particles from stack disposal, 18: 33801 (HW-80204)
electron density fluctuations in, radio transmission effects, 18: 34253
electron precipitation from auroral storms into, 18: 34671 (AFOSR-425)
fission products in, over Hungary during 1961 and 1962, 18: 33771
ionization in, from distant high-altitude nuclear explosions, 18: 34252
monitoring for alpha sources, 18: 33819
movements in, tracer studies on large-scale, 18: 34255
plutonium-239 content of, 18: 33819
potential gradient in, above ground of high radioactivity, 18: 33773
thermal radiation attenuation in, from high-altitude atomic explosions, 18: 34256
ATOMIC ENERGY
research programs of AECL, 18: 35241(R) (AECL-1972)
ATOMIC ENERGY OF CANADA LTD. CHALK RIVER PROJECT, CHALK RIVER, ONT.
research programs, 18: 35241(R) (AECL-1972)
ATOMIC EXPLOSIONS
atmospheric ionization from, theory for, 18: 34252
detection of, solar simulation testing of spacecraft for, 18: 33703
fallout from cratering, in basalt, 18: 33775
gamma dose from, calculation of secondary, 18: 34285 (WL-TDR-64-46(Vol.I))
mining broken rock from underground, 18: 33710
observations on 1962 Johnston Island, distant and near, 18: 34676
radiation from, atmospheric attenuation of thermal, 18: 34256
radionuclide distribution around cavity from, analysis of, 18: 33766 (HNS-1229-47)
use in creating subterranean chamber for submarine testing, feasibility of, 18: 33709 (SC-TM-64-636)
ATOMIC PHYSICS
energy of n-electron systems, 18: 34353
evaluation of Fermi integrals, method for, 18: 34654
ground state energies, molecular Schroedinger equation, 18: 34424
many-centered, polyelectronic integral matrices in quantum chemistry, Monte Carlo evaluation of, 18: 34423
molecular Schroedinger equation for, one-electron solution to, 18: 34422
transition probabilities in, expansion method for calculating dipole, 18: 34405 (NASA-CR-87)
wave functions of one- and two-electron systems, 18: 34425
ATOMIC STRUCTURE
electron orbitals in, geminal product approximation of, 18: 33554
ATOMS
electron wave functions for, calculation of hydrogen-like and single exponential, 18: 34428
energy level determinations on, photoelectron method for, 18: 34414
energy level transition probabilities for, calculation of dipole, 18: 34405 (NASA-CR-87)
energy of n-electron systems, 18: 34353
energy of, self-consistent field calculations for total, 18: 34437
motion in sextupole magnetic field, 18: 34369 (JINR-P-1681)

wave functions of, time-dependent perturbation theory of Hartree-Fock, 18: 34426
ATROPINE
radiosensitivity effects in mice, 18: 33368
AUGER ELECTRONS
spectra, 18: 34786
spectra of, from beta decay of tungsten-187, 18: 34804
AURORAL STORMS
altitude measurements in, photoelectric system for, 18: 34674
effects on electron precipitation into atmosphere, 18: 34671 (AFOSR-425)
measurement of, satellite instrumentation for, 18: 33935
observations on, simultaneous, 18: 34672
radio wave absorption in, nonthermal electron contribution to, 18: 34254
AUTOPSIES
cesium-137 content in samples from, in Japan, 18: 33263
AZO DYES
N-methylated amino-, binding reactions with rat liver proteins, 18: 33449(R) (NIRS-2(p.15-19))

B

BACTERIA
enzymes from *M. lysodeikticus*, preparation of RNA polymerase from, 18: 33243
genetic transformation in *Diplococcus pneumoniae*, 18: 33273(R) (NIRS-2(p.42-8))
polymerase from, catalytic reactions of RNA, 18: 33244
polymerase from, properties of RNA, 18: 33245
radiation effects on nucleic acid structure in, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on germination and growth of *B. subtilis* spores, 18: 33292
radiation effects on immunity to typhoid, 18: 33369
radiation effects on mouse sensitivity to endotoxins of, 18: 33370
radiosensitivity of, effects of DNA content on, 18: 33278 (STI/DOC/10/28(p.39-66))
radiosensitivity of lysogenic system of *Staphylococcus albus*, 18: 33278 (STI/DOC/10/28(p.39-66))
radiosensitivity of lactobacilli, effects of culture conditions on, 18: 33293
radiosensitivity of, effects of culture age and nucleic acid and protein contents on, 18: 33310
radiosensitivity of vegetative, effects of freezing on gamma, 18: 33326
radiosensitivity of desoxyribonucleic acid in *B. subtilis*, effects of 5-bromodeoxyuridine on, 18: 33402
radiosensitivity of spores of Clostridium and Barillus, effects of freezing and postirradiation heating on gamma, 18: 33996
BACTERIOPHAGES
radiation effects on genetic material in, effects of biological activity of DNA on, 18: 33278 (STI/DOC/10/28(p.39-66))
radioinduced mutations in T2, gamma, 18: 33297
BARIUM
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination in silicon, activation, 18: 33502
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
gamma attenuation at 0.1 to 10 Mev, coefficients for, 18: 35058
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
BARIUM BROMIDES
radioinduced coloration in, spectra of, 18: 33643
BARIUM CHLORIDES
beta scattering by, measurement of saturated backscattering from, 18: 35057
BARIUM CHLOROFLUORIDES
radioinduced coloration in, spectra of, 18: 33643
BARIUM FLUORIDES
BaF_x–CaF_2, lubricating properties of fused coatings of, in air, hydrogen, liquid sodium, and vacuum, 18: 33695 (NASA-TN-D-2348)
BARIUM IONS
binding to bovine serum albumin-stabilized emulsions, 18: 33575
distribution between phases in boron oxide–sodium chloride–sodium oxide system at 830°C, 18: 33534 (USNRDL-TR-760)
BARIUM ISOTOPES
separation of stable, in calutrons, 18: 34005(R) (ORNL-TM-879)
BARIUM ISOTOPES Ba-133
determination of physico-chemical state in liquid media, by paper electrophoresis and radioactivity recording, 18: 33590
BARIUM OXIDES
catalytic effects on radioinduced polymerization of solid 3,3-*bis*-chloromethyloxatane, 18: 33651
BARIUM PERCHLORATES
kryptonation, 18: 33450(R) (NYO-2757-4)
BARIUM SULFATES
radiation effects on stability of colloids of, 18: 33449(R) (NIRS-2(p.15-19))
reduction by hydrogen, 18: 33529 (ORNL-3334(Pt.II))
BARIUM TITANATES
radiation effects on crystal structure of, fast neutron, 18: 34241
BARLEY
radiation effects on seeds of, combined with mutagens, 18: 33375
radiation effects on growth of, effects of chlorides of sodium, calcium, and magnesium on, 18: 33409
strontium-90 uptake by, effects of calcium, potassium, and sodium on, 18: 33241
BARYONS
Feynman diagrams for conserved, majorization of, 18: 34521
interactions of, model of resonance, 18: 34564
interactions of, SU_3 model for strong, 18: 34510 (NP-14146)
interactions with pseudoscalar mesons, vector meson production in, 18: 34567
interactions with pseudoscalar mesons, unitary symmetry in, 18: 34585
mass spectrum of, 18: 34603
production in high-energy nucleon-nucleon interactions, 18: 34632
resonances with mesons in W_3 symmetry, 18: 34553
resonances with mesons, 45-fold $\frac{3}{2}^+$ multiplet of, 18: 34554
resonances with mesons in SU(3) with reciprocal bootstrap, 18: 34556
theory of, reciprocal bootstrap relation between decuplet $(\frac{3}{2})^+$ and octet $(\frac{1}{2})^+$ in, 18: 34575
BATTERIES
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
radiation effects on electrodes of nickel–cadmium, 18: 34213(R) (AI-64-11)
standard emf of lithium hydride cell at 540°C, 18: 35060(R) (ANL-6904)
BEARINGS
development for nuclear space propulsion systems, 18: 35216
review of MHD liquid-metal, 18: 33715
BEHAVIOR
conditioned reflex to radiation in fish and rabbits, 18: 33366
BENZENE
neutron transport in, 18: 34734
phosphorescence decay time in deuterated and natural, device for measuring, 18: 33637
radiolysis effects on yields in liquid cyclohexanone, 18: 33624
solvation of charge groups in, substituent effects on chemical equilibria and rate in, 18: 33613
benzene–SF_6, recombination rates for gaseous, 18: 33555
benzene–TBP, solvent properties for uranium from aqueous solutions, 18: 33681 (JEN-138-DQ/I-42)
BENZENE, ETHYNYL-
analysis for active hydrogen by NMR spectroscopy, 18: 33475
BENZENEARSONIC ACID, *o*-(1,8-DIHYDROXY-3,6-DISULFO-2-NAPHTHYLAZO)-
analytical use in uranium determinations, 18: 33463 (JEN-139-DQ/I-43)
BENZENESULFONIC ACID
hydroxy-, ion exchange equilibrium with cesium in aqueous alkaline solutions, 18: 33449(R) (NIRS-2(p.15-19))
BENZIMIDAZOLES
radiosensitivity effects on mice, x, 18: 33406
BENZOIC ACID, p-AMINO-
analysis for active hydrogen by NMR spectroscopy, 18: 33475
BENZOIC ACID, IODO-
labeling with iodine-131, 18: 33614
BERYLLIUM
analysis for sulfur, luminescent method for, 18: 33513
analysis of, gamma activation and wet chemical, 18: 35246(R) (MLM-1196)
bibliography on preparation, fabrication, and uses of, 18: 34151
brazing, 18: 34110
corrosion by water under ATR conditions, 18: 34074 (IDO-24460)
deformation and fracture of rolled, purity variations of, 18: 34140
dislocations and prismatic loops in, electron microscopy of slip, 18: 34168
ductility, effects of heat treatment on, 18: 34070(P)
electrorefining in large prototype cell, 18: 34031 (BM-RI-6489)
metallurgy of, review of research programs on, 18: 34042 (MAB-199-M(1))
production with increased ductility at high temperatures, 18: 34070(P)
production, properties, and working of hot-pressed billets of, 18: 34113

proton reactions at 3 Bev, deuterons, mesons(π), protons, and tritons from, 18: 34380
reactions with molybdenum silicides, 18: 34149
tensile properties of as-received and pickled fine wire of, 18: 34126 (NAMC-AML-1550)
uses in space vehicles, 18: 34141
wave functions of atomic, time-dependent perturbation theory of Hartree-Fock, 18: 34426
welding of, characteristics of electron beam, 18: 34112

BERYLLIUM ALLOYS
Al–Be, characteristics of electron beam welding of, 18: 34112
Be–Cu, alpha reactions with, secondary electron emission from, 18: 33911
Be–Cu, electron multiple emissions from, 18: 34450
Be–Cu, welding of heavy plates of, 18: 34111
Be–La, dissociation at high temperatures, 18: 34154
Be–Mo, crystal structure of MoB_{12} and MoB_{22}, 18: 34149
Be–Th–U, compatibility with Inconel, niobium, stainless steel, and tantalum at 1500°F, 18: 34032(R) (BMI-1668(Del.))
Be–Th–U, compatibility with metals and alloys at 1000 and 1500°F, 18: 34033(R) (BMI-1669(Del.))
Be–Th–U, compatibility with metals and alloys at 1500 and 2000°F, 18: 34034(R) (BMI-1672(Del.))
Be–Y, dissociation at high temperatures, 18: 34154

BERYLLIUM FLUORIDES
BeF–LiF, interface phenomena with liquid lead, 18: 34050(R) (ORNL-3626(p.59-164))
BeF_2–LiF, purification by removal of sulfates, 18: 34050(R) (ORNL-3626(p.59-164))
BeF_2–LiF–ThF_4–UF_4–ZrF_4, radiation effects on, 18: 34050(R) (ORNL-3626(p.59-164))
BeF_2–LiF–ZrF_4, crystallographic and phase studies on, 18: 34050(R) (ORNL-3626(p.59-164))
BeF_2–NaF–ThF_4, phase equilibria, 18: 33582

BERYLLIUM ISOTOPES Be-8
alpha elastic scattering by, exchange contribution to, 18: 34801
energy levels, 18: 34875

BERYLLIUM MODERATED REACTORS
design with horizontal beam tube, 18: 35232(P)

BERYLLIUM OXIDES
analysis for sulfur, luminescent method for, 18: 33513
annealing of irradiated, 18: 34040(R) (GEMP-36A)
development of coatings of, for fuel particles, 18: 34032(R) (BMI-1668 (Del.))
development of coatings of, for fuel particles, 18: 34033(R) (BMI-1669 (Del.))
grain orientation in extruded and sintered, 18: 34167
mechanical and physical properties, 18: 34040(R) (GEMP-36A)
preparation of high-purity powders of, method for, 18: 34064
radiation effects on fluorine-19-activated, ESR spectra of, 18: 33657
radiation effects on compacts of, at 583 to 1100°C, 18: 34224
radiation effects on microstructure of hot-pressed, annealing effects on, 18: 34225
radiation effects on microstructure of sintered, fast neutrons, 18: 34226
radioinduced dimensional changes in, relations with flux and temperature, 18: 34040(R) (GEMP-36A)
thermal stress resistance of fuels of, evaluation of, 18: 34166
Wigner energy of, calorimetric method for determining, 18: 34227
BeO–ThO_2–UO_2–Y_2O_3, fuel retention at high temperatures, 18: 34040(R) (GEMP-36A)
BeO–ThO_2–UO_2–Y_2O_3, mechanical and thermal properties of, 18: 34040(R) (GEMP-36A)
BeO–UO_2, fission gas release from irradiated dispersion of, 18: 34033(R) (BMI-1669(Del.))
BeO–UO_2, fission gas release from irradiated, at 1200 to 1600°C, 18: 34034(R) (BMI-1672(Del.))

BESSEL FUNCTIONS
expansion for integrals containing, asymptotic, 18: 34022

BETA DECAY
amplitudes in, formulation of transition, 18: 34938
book: *Once-Forbidden Beta-Transitions*, 18: 34957(T)
theory of, for various nuclei, 18: 34752(R) (CU(PNPL)-234)
theory of, formulation for transition, 18: 34937
transitions ($0^+ \leftrightarrow 0^-$), 18: 34808

BETA-DIFFRACTION ANALYSIS
angular dependence of scattering in analysis of two- and three-component mixtures, 18: 33469(T) (AEC-tr-6399(p.72-82))

BETA PARTICLES
detection and measurement of low levels of, in liquids, scintillation apparatus for, 18: 33974(P)
detection by semiconductor detectors, response for, 18: 33916
dosimetry of gross fission product, 18: 33633
effects of, from deposited phosphorus-32 on metabolism in nervous system of rats, 18: 33278 (STI/DOC/10/28(p.39-66))
pathological effects of single and fractionated doses on skin of rats, 18: 33340
polarization measurements on, method for, 18: 34877
scattering by alloys, elements, heavy water, radioisotopes, and salt solutions, 18: 35057

BETA SOURCES
activity measurements of, use of 4π counters for absolute, 18: 33946
counting of, automatic sample changer for, 18: 33716
detection using scintillation counters, 18: 33220
measurement in layered preparations, scintillation, 18: 33659
preparation of, microcolumn technique for, 18: 33654
use in vacuum gages, 18: 33999

BETA SPECTRA
analysis of low-energy, 18: 34786
radioinduced in biological materials, research program on, 18: 33274(R) (NYO-910-1)

BETA SPECTROMETERS
design of high-precision prism-type, 18: 33948
design of 50-cm double-focusing, 18: 33947
performance of coincidence-type scintillation, 18: 34274(R) (NIRS-2 (p.3-15))
performance of silicon semiconductor, 18: 34752(R) (CU(PNPL)-234)

BIBLIOGRAPHIES
on analytical chemistry of niobium and tantalum, 18: 33482
on atmosphere and space, 18: 34383(T) (NASA-TT-F-229)
on chlorine trifluoride, 18: 33522 (CEA-2360)
on d-c polarography, 18: 33452 (ORNL-P-145)
on electromagnetic levitation of metals, 18: 34057 (UCRL-11411)
on electron spin resonance spectra of oriented radicals, 18: 33630
on fuel element cladding materials, 18: 34076 (TID-8540(p.213-330))
on heat exchangers for gas-cooled power reactors, 18: 35150 (NYO-9789)
on heavy water production, 18: 34008 (TID-3091(Suppl.1))
on high-temperature protective coatings for graphite, 18: 34043 (ML-TDR-64-173(Pt.I))
on less common metals for process equipment, 18: 34151
on low-energy electron spectra, 18: 34786
on metallic reactor fuels, 18: 34130 (TID-8540(p.331-410))
on Mossbauer effect in chemistry, 18: 33604(T)
on neutron scattering by crystals, 18: 34455
on neutron-induced nuclear reaction cross sections, 18: 34753(R) (EANDC(E)-50(L))
on non-strange resonances, 18: 34636
on pebble-bed reactor concepts, 18: 35119 (ANL-6892)
on plutonium alloys and systems, 18: 34125 (KFK-220)
on post-therapeutic radionecroses of central nervous system, 18: 33290
on quantum conversion in chloroplasts, 18: 33218
on radiation effects on plants, 18: 33284(T) (AEC-tr-5836)
on radiation effects on corrosion of structural materials, 18: 34036 (CEA-Bib-16)
on radioecology of marine organisms, 18: 33230
on reactor fuel processing, 18: 33683 (TID-8540(p.411-76))
on ring oven technique, 18: 33497
on SNAP program, 18: 35204 (TID-3561(Rev.4))
on solid state of rare gases, 18: 34355
on surface kinetics techniques, 18: 33454
on x-ray-diffraction analysis of radioactive minerals, 18: 33794 (NP-14176)

BIG ROCK POINT POWER REACTOR
chemical aspects of, 18: 35186

BINDING ENERGY
measurement from (d,p) and (d,t) reactions in heavy nuclei of A = 91 to 209, 18: 34966

BIOCHEMISTRY
oxygen-18 in, 18: 33257

BIOLOGICAL MATERIALS
analysis for silver, selenium, tellurium, and dysprosium, design of automated instrumental system for, activation, 18: 33464 (NASA-CR-52997)
book: *Electron Spin Resonance in Biology*, 18: 33227
radiation effects on, research program on free radical production and secondary electron spectra, 18: 33274(R) (NYO-910-1)

BIOLOGICAL MODELS
for radiation recovery in cells, statistical, 18: 33355
radiation effects in, 18: 33283(R) (TID-20889)

BIOLOGICAL SYSTEMS
isotope effects on, hydrogen, oxygen, and nitrogen, 18: 33258
radioinduced magnetic resonance in, 18: 33283(R) (TID-20889)

BIOLUMINESCENCE

microscopy of, image intensifiers for, 18: 33221
BIOMETRY
mathematical models for plutonium metabolism in man, 18: 33267
BIOPHYSICS
quantum conversion in chloroplasts, 18: 33218
BIOSYNTHESIS
of sinigrin, 18: 33270(R) (NIRS-2(p.23-6))
radiation effects on testicular androgen, 18: 33316
BIOTITES
age estimation by argon–krypton and rubidium–strontium methods, 18: 33781
deuterium content of, from rhyolitic lavas, 18: 33788
BIPHENYL
fluorescence decay time in deuterated and natural, device for measuring, 18: 33637
neutron diffusion in, 18: 34734
phosphorescence decay time in deuterated and natural, device for measuring, 18: 33637
spectra of low-frequency vibrations in, by inelastic neutron scattering, 18: 34302
viscosity at high pressures and temperatures, 18: 33858
biphenyl–terphenyl, radiolysis and pyrolysis, 18: 33617 (AECL-1915)
BIPYRIDINES
complexes with iron and iron cyanides, electron transfer in cerium oxidation of, 18: 33550
BISMUTH
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
density of liquid, 18: 34131 (TID-20849)
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
electron reactions (e,n) at 16 Mev, neutron spectra of, 18: 34945
gamma reactions (γ,n) with, neutron angular distribution from, 18: 34935
neutron filtering properties of "single" crystals of, 18: 34752(R) (CU(PNPL)-234)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
photoelectric effect in, relativistic, 18: 34847
BISMUTH ALLOYS
Bi–Li, thermodynamic properties at 775 to 1150°K, 18: 33678(R) (ANL-6875)
Bi–Pb, superconductivity of, surface effects on, 18: 34683(R) (NP-14136)
BISMUTH ISOTOPES Bi-207
beta decay of, analysis using silicon detectors, 18: 34752(R) (CU(PNPL)-234)
BISMUTH ISOTOPES Bi-208
energy levels, 18: 35246(R) (MLM-1196)
energy levels of, parameters for, 18: 34777 (UCRL-11238)
BISMUTH ISOTOPES Bi-209
alpha reactions (α,n) at 15 to 26 Mev, differential cross sections for, 18: 34777 (UCRL-11238)
helium ion fission of, fragments in, 18: 34880
neutron inelastic scattering by, analysis of, 18: 34910
oxygen-16 reactions at 75 to 165 Mev, recoil studies for, 18: 34782 (UCRL-11563)
BISMUTH ISOTOPES Bi-210
beta decay of, internal bremsstrahlung from, 18: 34837
BISMUTH MOLYBDATES
$Bi_2(MoO_4)_3$–$PbMoO_4$, phase diagram, 18: 34195
BLACK HILLS (U. S.)
granite gneiss discovery in, 18: 33768
BLACK SEA
radioactivity during 1959–1960, 18: 33779
BLAST EFFECTS
measurement from 20-ton TNT charge on ground, 18: 34278 (NP-14174 (Vol.1))
BLOOD
cesium-137 content in samples of, from Japanese population, 1963, 18: 33263
radiation effects on electrolyte distribution in rat, gamma, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on content of trace elements in, 18: 33285(T) (JPRS-25502)
radiation effects in stored, 18: 33345
radiation effects on proteolysis in rat, x, 18: 33362
radiation effects on human, *in utero* exposure, 18: 33391
BLOOD CELLS
automatic pattern-recognition techniques for, 18: 35256
BLOOD CIRCULATION
to embryos, effects on radiosensitivity of rat and mouse, 18: 33423
BLOOD DISEASES
radioinduced thrombocytopenia, 18: 33291
treatment of thrombocytopenia and leukopenia with stored platelets or leukocytes, 18: 33215(R) (TID-20824)
BLOOD PICTURE
radiation effects on mouse, effects of hormones on, 18: 33416
BLOOD PLASMA
iodine-131 uptake by, in animals and chickens, 18: 33251
BLOOD PLATELETS
antigenic composition and function of, in rats, 18: 33215(R) (TID-20824)
radiation effects on, 18: 33291
storage of viable, in frozen state, 18: 33215(R) (TID-20824)
BLOOD PRESSURE
radiation effects on procaine effects on rabbit, 18: 33304
radiation effects on rabbit, gamma, 18: 33364
BLOOD SERUM
radiation and temperature effects on ultraviolet absorption and protein content in rat, 18: 33335
radiation effects on electrophoretic distribution of proteins in, *in vitro*, 18: 33353
reactions of albumin from, with polyribonucleotides, 18: 33247
BLOOD VESSELS
radiation effects on, radiographic method for determining, 18: 33289
radiation effects on, 18: 33291
BOILERS
design and development of 16- and 69-pin bundle, 18: 33729(R) (ACNP-64027)
design and development of L-shaped, for liquid metals, 18: 35197(R) (64SD700)
development for nuclear space propulsion systems, 18: 35216
development of sodium-heated steam generators, 18: 33741(R) (TID-20603)
survey for gas-cooled power reactors, 18: 35150 (NYO-9789)
BOILING
bubble dynamics in nucleate, effects of gravity on, 18: 33736 (NASA-TN-D-2299)
burnout detection in cooling pipes, radiometric instrument for, 18: 33846(T) (AEC-tr-6399(p.30-42))
burnout in pool and forced-convection, studies, 18: 33737 (ORNL-P-18)
burnout in, use in reactor design, 18: 35162 (TID-8540(p.131-76))
critical heat flux in swirl flow with heated twisted tapes, 18: 33738 (ORNL-TM-894)
heat transfer in critical, in vertical pipes, 18: 33743
heat transfer in transition, to rods in channel flow, 18: 33734(R) (GEAP-4646)
void fraction measurement in water loops, 18: 33739 (RT/ING(64)-5)
void volume measurements in, by gamma attenuation and manometer techniques, 18: 33729(R) (ACNP-64027)
BOILING REACTOR EXPERIMENTS
excursions in BORAX-I, analysis of, 18: 35068(R) (STL-6312)
instrumentation for detecting foam–water interfaces in Borax V, 18: 33830(R) (NYO-10556)
instrumentation for detecting foam–water interfaces in Borax-V, 18: 33831(R) (NYO-10558)
instrumentation for detecting foam–water interfaces in Borax-V, 18: 33832(R) (NYO-10560)
measurements during power and zero-power experiments on BORAX-V PSH-1, 18: 35060(R) (ANL-6904)
BOILING REACTORS
containment vessel for, 18: 35099(P)
cooling system for, test loop for simulation of, 18: 35090(T) (ANL-Trans-52)
criticality studies of, with plutonium recycling, 18: 35168
design of, boiling burnout considerations in, 18: 35162 (TID-8540 (p.131-76))
design with reactivity control, 18: 35217(P)
development for electric power production in Canada, 18: 35173
economics, 18: 35174
excursions in, steam-void formation during fast, 18: 35223(R) (STL-372-6)
fuel element cladding behavior in, 18: 34076 (TID-8540(p.213-330))
fuel elements for, burnout studies on "nuclear vapotron", 18: 34090(T) (EURAEC-1015)
hydrodynamic characteristics of heterogeneous, 18: 35067(R) (STL-372-3)
kinetics, 18: 33733(R) (EURAEC-1127)
reactivity variations due to random boiling in, minimization of, 18: 35062 (EURAEC-1138)
transfer functions for two-phase-flow, from noise of steam-void, 18: 35073 (TID-7679(p.155-69))
waste gas disposal systems for, 18: 35181

BONE MARROW
aspiration of, in mice, 18: 33223
heme synthesis by *in vitro* cells of, effects of erythropoietin, 18: 33242
hemoglobin and DNA content in erythrocyte precursors in, 18: 33234 (UCRL-11459)
radiation effects on acceptance of injected by rats, effects of immune reactions on, 18: 33387
radiation effects on morphology of cells in, fluorescence microscopic observations on, 18: 33399
radioinduced nucleated cell depletion in, 18: 33351
radiosensitivity effects of transplants of mouse parental, 18: 33320
regeneration of human and rabbits, 18: 33216
transformation of cells of injected, in irradiated dogs, 18: 33337
transplantation effects of hemopoietic cells of, against radiation sickness in man, 18: 33403
BONE TUMORS
radiotherapy of, tracer study of metabolism in, 18: 33233(R) (NYO-910-9)
BONES
calcium-45 metabolism, of rabbits, 18: 33261
cerium-144 uptake by rat, 18: 33252
composition of human, effects of age on, 18: 33276(R) (NYO-910-7)
mineral content of, in normal and rachitic rats, effects of vitamin D on, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on metabolism in, of dogs, 18: 33232(R) (NYO-910-3)
radiation effects on composition of, in mice, 18: 33276(R) (NYO-910-7)
radiation injuries of cranial, after radiotherapy, 18: 33338
radioactivity of caribou, analysis of gamma, 18: 33926
strontium-85 removal from human, using parathyroid hormone, 18: 33231(R) (NIRS-2(p.49-56))
strontium-90 content in, of cattle, sheep, and swine, species and individual differences in, 18: 33240
strontium-90 metabolism in, of rabbits, 18: 33261
BORON
determination of microquantities of, mass spectrometric, 18: 33479
diffusion in boron carbide–uranium dioxide compacts, 18: 35126(R) (CEND-3107-216)
effects on neutron-irradiation effects on superconductors, 18: 34683(R) (NP-14136)
performance as dopant in lithium-drifted silicon junctions, ion-pairing in, 18: 33922
BORON CARBIDES
B_4C–UO_2, properties of vibratory-compacted, 18: 35126(R) (CEND-3107-216)
BORON CHLORIDES
BCl_3–H–SiCl, reaction with boron–molybdenum–silicon systems, 18: 34146
BORON COMPOUNDS
pharmacology of, 18: 33431 (TID-20856)
BORON IONS
reactions with n-type silicon, implantation doping from, 18: 33921
BORON ISOTOPES B-9
energy levels of, search for $\frac{1}{2}^+$ (1.7-Mev), 18: 34892
BORON ISOTOPES B-10
determination of microquantities of, mass spectrometric, 18: 33479
neutron capture by, use of reaction in radiotherapy of brain tumors, 18: 33431 (TID-20856)
neutron reactions (n,t) at 14.4 Mev, triton angular distributions in, 18: 34830
neutron reactions (n,α), chemical effects of recoils on methanol, 18: 33618 (CONF-322-14)
proton reactions (p,d) at 11 Mev, boron-9 energy levels from, 18: 34892
BORON ISOTOPES B-11
determination of microquantities of, mass spectrometric, 18: 33479
deuteron reactions at 7 Mev, yields from, 18: 33932
deuteron reactions (d,p) at 1 to 2.6 Mev, differential cross sections for, 18: 34909
proton reactions (p,γ) with, cross sections, 18: 34752(R) (CU(PNPL)-234)
BORON ISOTOPES B-12
beta decay of, conserved-vector-current theory for, 18: 34752(R) (CU(PNPL)-234)
BORON NITRIDES
properties as diffusion barrier for refractory metals, 18: 34029(R) (AD-601740)
BORON OXIDES
B_2O_3–NaCl–Na_2O, distribution of solutes between phases in, at 830°C, 18: 33534 (USNRDL-TR-760)
BORON SYSTEMS
B–H_2O, neutron spectra in, 18: 34733
B–Mo–Si, diffusion reactions in boron chloride–hydrogen–silicon chloride, 18: 34146
B–Th–U, compression tests of $(Th,U)B_4$, 18: 34034(R) (BMI-1672(Del.))
BOSONS
decay of W, two-meson, 18: 34565
interactions in many-body systems of, excitation spectrum of, 18: 34702
interactions of, model of resonance, 18: 34564
mass of pseudoscalar, origin of, 18: 34608
perturbation expansion for interacting system of, at zero temperature, 18: 34686
properties of dense systems of, low-temperature, 18: 34665
theory of degenerate system of interacting, quantum-statistical, 18: 34337
theory of degenerate system of interacting, lambda transformation in quantum-statistical, 18: 34338
theory of degenerate system of, as dilute gas of hard spheres, 18: 34339
BRAIN
blood circulation in, tracer studies of, 18: 33441
boron content in, 18: 33431 (TID-20856)
radiation effects on acetylcholine and sympathin content in rat, effects of aminazine on, 18: 33325
radiation effects on sorption in mouse, fission-product, 18: 33358
BRAIN TUMORS
radiodiagnosis of, by positron scanning after injection of arsenic-74 or copper-64, 18: 33432
radiotherapy of, use of neutron capture in boron-10 for, 18: 33431 (TID-20856)
BRAZING
book: *Welding and Brazing Techniques for Nuclear Reactor Components*, 18: 34100
BRAZING ALLOYS
development of zirconium-base, for brazing zirconium alloys into corrosion-resistant structures, 18: 34114(P)
properties evaluation for joining beryllium, 18: 34110
BREATH
analysis for radon of, from persons with radium body burdens, 18: 33262
radon-220 in Thorotrast-patient, 18: 33425
BREEDER REACTORS
core design for, with alternate depleted and enriched fuel zones, 18: 35192(P)
criticality studies of, with plutonium recycling, 18: 35168
design of settled-bed, 18: 35124(P)
BREMSSTRAHLUNG
effects on activity of rat desoxyribonuclease, 18: 33361
emission of internal, in nuclear beta decay, 18: 34837
production by krypton-85 sorber on carbon–gold system, 18: 34287(T) (NP-tr-1160)
production by 10- and 20-Mev electrons on aluminum and tantalum, 18: 34459
reactions with $7 < A < 65$ nuclei, resonance fluorescence in, 18: 34852
BROMIDE IONS
with americium, neptunium, and plutonium in solutions, spectrophotometric and ion exchange studies, 18: 33526 (IA-924)
BROMIDES
effects on conditioned reflexes in normal and irradiated dogs, 18: 33319
BROMINE
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination in silicon, activation, 18: 33502
gamma attenuation at 0.1 to 10 Mev, coefficients for, 18: 35058
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
neutron resonance absorption parameters of, 18: 34752(R) (CU(PNPL)-234)
proton reactions at 2 to 9 Bev, fragment angular correlations for, 18: 34940
radiolysis effects on hydrogen formation in gaseous hydrochloric acid, 18: 33625
BROMINE IONS
electron energy levels of, quadrupole antishielding factors for, 18: 34442
BROMINE ISOTOPES Br-77
decay of, selenium-77 energy levels from, 18: 34895
BROMINE ISOTOPES Br-79
Auger effect in, K, 18: 34788
energy levels in, vibrational, 18: 34790
nuclear magnetic resonance in chromium bromide, 18: 33584
BROMINE ISOTOPES Br-80
energy levels of, lifetime of 37-kev, 18: 34845
BROMINE ISOTOPES Br-81
nuclear magnetic resonance in chromium bromide, 18: 33584
BROMINE ISOTOPES Br-82
beta decay scheme, 18: 34845

BROOKHAVEN ALTERNATING-GRADIENT SYNCHROTRON
beam separator design for, 18: 34365 (BNL-8145)
BROWNIAN MOVEMENT
trapped trajectories in, 18: 34311
BUBBLE CHAMBERS
photographs of, automatic gap counting and measuring system for, 18: 33971
photographs of, scanning and measuring projector for, 18: 33957
seals for superconducting-magnet, low-temperature, 18: 34685
BUBBLES
detection in liquid sodium, apparatus for, 18: 33827 (EUR-1823.d)
dynamics in nucleate boiling in aqueous solutions, effects of gravity on, 18: 33736 (NASA-TN-D-2299)
BUILDING MATERIALS
development for nuclear space propulsion systems, 18: 35216
manufacture, use of radiometric instruments in, 18: 33852(T) (AEC-tr-6399(p.196-201))
use for low-activity laboratories, 18: 35050
BURNS
effects with radiation on amino nitrogen, nonprotein, protein fractions, and serum protein contents in rats, 18: 33381
BUTADIENE
ionization of, appearance potential measurement on secondary ions produced by, 18: 33569
BUTADIENE, 2,3-DIMETHYL-
radiolysis effects on yields in liquid cyclohexanone, 18: 33624
BUTANE, 1-BROMO-
radioinduced reactions with tin, product yields in, 18: 34032(R) (BMI-1668(Del.))
radioinduced reactions with tin, effects of variables on products of, 18: 34033(R) (BMI-1669(Del.))
radioinduced reactions with tin, dose effects on product yields in, 18: 34034(R) (BMI-1672(Del.))
BUTANE, 2-METHYL-
2-methylbutane–propane, fugacity coefficients from equation of state for, 18: 33531 (UCRL-11369)
BUTANEDIOLS
analysis for active hydrogen by NMR spectroscopy, 18: 33475
1,3-BUTANEDIONE, 1-PHENYL- COMPLEXES
with europium and diethylamine, morpholine, or piperidine, ligand field spectra of, 18: 33565
with europium, laser properties of, 18: 33561
with europium, quenching and temperature dependence of fluorescence in, 18: 33556
1-BUTANOL, 3-METHYL-
glycerol–3-methyl-1-butanol, immiscibility boundary, 18: 34131 (TID-20849)
BUTENE POLYMERS
radiation effects on infrared and x spectra of, gamma, 18: 34220 (TID-20787)
spectra, effects of melting on infrared, 18: 34220 (TID-20787)
BUTYL PHOSPHATES
ethyl acetate–TBP, solvent properties for uranium from aqueous solutions, 18: 33680 (JEN-137-DQ/I-41)
solvent properties for metallic ions, 18: 33685
benzene–TBP, solvent properties for uranium from aqueous solutions, 18: 33681 (JEN-138-DQ/I-42)
cyclohexane–TBP, solvent properties for uranium from aqueous solutions, 18: 33681 (JEN-138-DQ/I-42)
HF–TBP, solvent properties for niobium and tantalum, 18: 33688
4-methyl-2-pentanone–TBP, solvent properties for uranium from aqueous solutions, 18: 33679 (JEN-136-DQ/I-40)
BUTYRONITRILE
nitrogen-14 NQR in, relaxation of, 18: 33615

C

CADARACHE REACTORS (RAPSODIE)
control rod worth measurements on mockups in ZPR-III, 18: 35060(R) (ANL-6904)
CADMIUM
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination in silicon, activation, 18: 33502
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
neutron elastic scattering cross sections of natural, 18: 35060(R) (ANL-6904)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
radiation effects on electrodes of, in nickel–cadmium batteries, 18: 34213(R) (AI-64-11)
spectra of, x-ray L-absorption and -emission, 18: 34412
x-ray emission band of Ly_{α}, 18: 34411
x-ray L-emission spectrum, 18: 34410
CADMIUM ALLOYS
Cd–Ce, crystallization from liquid cadmium, precipitation of ternary addition with $CeCd_{11}$ in, 18: 34192
Cd–La, thermodynamic properties, 18: 33678(R) (ANL-6875)
Cd–Mg–Zn, solubility of praseodymium and uranium in, 18: 33678(R) (ANL-6875)
Cd–Nd, formation of $NdCd_{11}$ compound, free energy of, 18: 35060(R) (ANL-6904)
Cd–Pu, phase studies and thermodynamic properties, 18: 33678(R) (ANL-6875)
CADMIUM ISOTOPES Cd-114
deuteron reactions (d,p) with, distorted-wave approximation for, 18: 34774 (ORNL-P-144)
CADMIUM ISOTOPES Cd-115
production of isomer pairs of, in proton reactions ($p,p\pi^+$) with indium-115 at 130 and 200 Mev, 18: 34946
CADMIUM SULFIDES
photocurrent induced by x rays in single crystals of, spectral distribution, 18: 34286(T) (AEC-tr-6399(p.186-95))
photoresponse of crystals of, 18: 34280(R) (NYO-2680-1)
CADMIUM SYSTEMS
Cd–H_2O, neutron spectra in, 18: 34733
CALCITES
origin of, oxygen isotope studies on, 18: 33786
oxygen isotope fractionation between quartz, magnetite and, for geothermometry, 18: 33785
CALCIUM
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
content in Pacific skeletal aragonites, 18: 33259
contents in meteorites, 18: 34398
determination in silicon, activation, 18: 33502
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
deuteron reactions (d,p) at 7 to 12 Mev, distorted-wave approximation for, 18: 34774 (ORNL-P-144)
effects on fluorescence of uranium sodium carbonate–sodium fluoride melts, 18: 33506
effects on growth and nitrogen fixation in Nostoc, 18: 33237
effects on uptake of strontium-90 by barley and pea plants, 18: 33241
metabolism by rats, effects of diet on, 18: 33805(R) (NIRS-2(p.57-67))
metabolism in man in health and disease, tracer studies of, 18: 33277 (STI/DOC/10/28(p.21-38))
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
separation from strontium by solvent extraction, effects of sodium concentration in organic feed on, 18: 34007(R) (ORNL-TM-890)
uptake by fish gills, comparison with strontium, 18: 33805(R) (NIRS-2(p.57-67))
CALCIUM ALLOYS
Ca–Li, phase diagram, 18: 34131 (TID-20849)
CALCIUM CARBONATES
radiation effects on crystal structure of, fast neutron, 18: 34241
strontium precipitation from soils using, 18: 33594
CALCIUM CHLORIDES
radiosensitivity effect on barley seeds, 18: 33409
CALCIUM FLUORIDES
radioinduced coloration in, spectra of, 18: 33643
vibrations of negative deuterium and hydrogen impurity ions in crystals of, 18: 34262 (AFCRL-64-284)
BaF_2–CaF_2, lubricating properties of fused coatings of, in air, hydrogen, liquid sodium, and vacuum, 18: 33695 (NASA-TN-D-2348)
CaF_2–LiF, lubricating properties of fused coatings of, in air, hydrogen, liquid sodium, and vacuum, 18: 33695 (NASA-TN-D-2348)
CaF_2–NaF, lubricating properties of fused coatings of, in air, hydrogen, liquid sodium, and vacuum, 18: 33695 (NASA-TN-D-2348)
CALCIUM IONS
binding to bovine serum albumin-stabilized emulsions, 18: 33575
CALCIUM ISOTOPES
separation in calutrons, 18: 34007(R) (ORNL-TM-890)
separation of stable, in calutrons, 18: 34005(R) (ORNL-TM-879)
CALCIUM ISOTOPES Ca-40
alpha reactions (α,d) at 45 to 50 Mev, highly populated levels in,

18: 34779 (UCRL-11341)
deuteron inelastic scattering at 7 to 12 Mev, distorted-wave approximation for, 18: 34774 (ORNL-P-144)
deuteron reactions (d,p) at 7 to 12 Mev, distorted-wave approximation for, 18: 34774 (ORNL-P-144)
energy levels of, supermultiplet and unitary symmetries classification in collective model for, 18: 34897
energy levels of, particle-hole approximations for odd-parity, 18: 34831
energy levels, parity and spin of resonance, 18: 34784
gamma emission in 0^+-0^+ transitions in, double, 18: 34752(R) (CU(PNPL)-234)
gamma reactions (γ,n) and (γ,p) with, resonances in, 18: 34629
neutron reactions (n,α) at 14 Mev, differential cross sections for, 18: 34841
nuclear structure of, alpha cluster reduced widths for, 18: 34891
proton reactions (p,d) at 55 Mev, differential cross sections for, 18: 34757 (INSJ-72)
x-ray emission from μ-mesic, calcium-44 isotope shift in, 18: 34900

CALCIUM ISOTOPES Ca-42
helium ion reactions (He-3,p) at 10 to 15 Mev, 18: 34960

CALCIUM ISOTOPES Ca-44
x-ray emission from μ-mesic, calcium-50 isotope shift in, 18: 34900

CALCIUM ISOTOPES Ca-45
metabolism of, in bones of rabbits, 18: 33261

CALCIUM ISOTOPES Ca-47
distribution of tracer dose in man, whole-body counting of, 18: 33233(R) (NYO-910-9)

CALCIUM ISOTOPES Ca-48
deuteron reactions (d,p) with, 18: 34905

CALCIUM ISOTOPES Ca-49
energy levels, 18: 34905

CALCIUM OXIDES
effects on properties and sinterability of zirconium oxide, 18: 34155
positron annihilation in, angular correlations from, 18: 33605

CALCIUM PHOSPHATES
radiolysis of, hydrogen yields in, 18: 33645

CALCIUM SULFATES
kryptonation, 18: 33450(R) (NYO-2757-4)
reduction by hydrogen, 18: 33529 (ORNL-3334(Pt.II))

CALCIUM TITANATES
radiation effects on crystal structure of, fast neutron, 18: 34241

CALDER HALL REACTORS
cooling system treatment for corrosion inhibition, 18: 35063 (IG-Report-52)
design, construction, and commissioning of Hunterston, 18: 35177

CALIFORNIA
rubidium and strontium redistribution during metamorphism in Panamint Range, 18: 33793

CALIFORNIUM ISOTOPES Cf-252
fission of, cluster-model, 18: 34872

CALORIMETERS
description of high-temperature, 18: 34131 (TID-20849)
design for measuring enthalpy increments up to 1500°C, 18: 33678(R) (ANL-6875)
use for determining x-ray total beam energy, 18: 34274(R) (NIRS-2(p.3-15))

CALORIMETRY
design for Wigner energy determination, 18: 34227
fluorine bomb methods in, 18: 33678(R) (ANL-6875)

CALUTRONS
ion collector development and preparation for, 18: 34007(R) (ORNL-TM-890)
ion receivers for, development for single-crystal deposition, 18: 34005(R) (ORNL-TM-879)
ion sources for, development of internally valved feed system for, 18: 34005(R) (ORNL-TM-879)
operation, 18: 34006(R) (ORNL-TM-889)
operation of, two-arc, 18: 34005(R) (ORNL-TM-879)
operations, 18: 34007(R) (ORNL-TM-890)
sample contamination in, mechanisms of, 18: 34005(R) (ORNL-TM-879)

CAMBRIDGE SYNCHROTRON
design and operation, 18: 34367 (CEAL-1000)

CAMPHOR
neutron scattering in, at 4 to 11 Å, 18: 34752(R) (CU(PNPL)-234)

CANDU REACTOR
development of, review, 18: 35171
economic comparison with Nine Mile Point and Oyster Creek Boiling Water Reactors, 18: 35172
fuel element irradiation testing in HWCTR, 18: 35061(R) (DPST-64-83-6)
operations, 18: 35153(R) (SRO-103)

CAPILLARIES
fabrication of vertical-orifice Teflon, for Teflon dropping-mercury electrode, 18: 33451 (ORNL-3654)

CARBAZOLE, VINYL- POLYMERS
radiation effects on infrared spectra of, gamma, 18: 34220 (TID-20787)

CARBON
contents in meteorites, 18: 34398
deposition of coatings of pyrolytic, on fuel particles, 18: 34033(R) (BMI-1669(Del.))
determination in refractory metals, review of methods for, 18: 33515
determination in refractory metals, review of methods for, 18: 33516
determination in sodium, 18: 33678(R) (ANL-6875)
determination in sodium by isotope dilution mass spectrometry, 18: 33477
development of coatings of pyrolytic, for fuel particles, 18: 34032(R) (BMI-1668(Del.))
development of coatings of pyrolytic, for fuel particles, 18: 34034(R) (BMI-1672(Del.))
diffusion in uranium dicarbide at 1900 to 2050°C, 18: 34033(R) (BMI-1669(Del.))
effects on tantalum–tungsten alloys, 18: 34059(R) (WANL-PR(Q)-003)
effects on tensile properties of niobium–tungsten alloys, 18: 34197
electron reactions at 1 and 4 Bev, proton production in, 18: 34916
electron scattering by, energy loss mechanisms in relativistic, 18: 34258(R) (AD-417250)
meson (μ^-) capture from protons, x-ray yields in, 18: 34947
meson (π) scattering at 80 Mev, high-energy approximation, 18: 34911
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
preparation from methane by pyrolysis, 18: 35246(R) (MLM-1196)
production in evolution of massive hydrogen stars, 18: 34386
proton elastic scattering at 6.7 Mev, polarized, 18: 34809
proton energy losses at 992 kev, distributions of, 18: 34918
radiation effects on pyrolytic, in fluoride salt baths, 18: 34050(R) (ORNL-3626(p.59-164))
reactions with uranium dioxide for preparation of uranium–uranium carbide cermets, 18: 34115(P)
stripping electron microscopic replicas of, chemical, 18: 33549

CARBON (ACTIVATED)
sorptive properties for iodine-131 in air, 18: 33808(T) (AEC-tr-6459)
sorptive properties for krypton-85 as bremsstrahlung sources, 18: 34287(T) (NP-tr-1160)

CARBON CATALYSTS
C–Pt, poisoning by hydrogen during isotopic exchange in water, 18: 33527 (IFA-28-IS)

CARBON DIOXIDES
collection by liquid scintillation, design of vial reaction tube for, 18: 33478
determination in argon in gas chromatography, electron drift velocity detector for, 18: 33476
isotope effects on molecular dipole moments of, 18: 33597
neutron total cross sections near critical point, 18: 34752(R) (CU(PNPL)-234)
radiation effects on exchange by *Pinus rigida*, 18: 33315
reactions with nuclear-grade graphite, review of thermal, 18: 33525 (HW-74663)

CARBON IONS
reactions (C-12,α) with carbon-12, 18: 34958

CARBON ISOTOPES C-10
energy levels of, model for, 18: 34833

CARBON ISOTOPES C-12
alpha decay of, angular distribution in 3-body, 18: 34868
alpha reactions (α,d) at 45 to 50 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
carbon ion reactions (C-12,α) with, 18: 34958
carbon reactions (C-12,α) at 16 to 22 Mev, de-excitation branching in, 18: 34842
charged-particle scattering at 5 to 60 Mev, crossover technique for energy determination in, 18: 34934
deuteron reactions at 7 and 9 Mev, yields from, 18: 33932
deuteron reactions (d,n) with, determination of deuterium in organic compounds by, 18: 33486
energy levels of, in particle-hole model, 18: 34824
helium reactions (He-3,p) at 13.9 and 31.2 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
meson (π^-) capture by, nucleon correlations from, 18: 34851
proton cascade reactions with, Monte Carlo calculations on, 18: 34922
proton inelastic scattering at 147 Mev, 18: 34816
reactions (C-12,α) with carbon-12 at 16 to 22 Mev, de-excitation branching in, 18: 34842
reactions (C-12,C-11) with rhodium at 10 Mev, differential cross sections for, 18: 34951
scattering by nuclei, distorted-wave approximation for inelastic, 18: 34774 (ORNL-P-144)

scattering by nuclei, diffraction mechanism for elastic, 18: 34848
transitions in light, $\Delta T = 0$, 18: 34858

CARBON ISOTOPES C-13
isotope effects in substitution reactions of methyl iodide, calculated, 18: 33612 (BNL-8066)
isotope effects on decarboxylation oxalacetic acid, 18: 33598
separation by thermal diffusion, 18: 34005(R) (ORNL-TM-879)

CARBON ISOTOPES C-14
determination in aqueous solutions, liquid scintillation spectrometer for, 18: 34274(R) (NIRS-2(p.3-15))
determination in urine, 18: 33518
determination of, evaluation of liquid scintillation solvent systems for, 18: 33938
tracer uses, 18: 33373

CARBON MONOXIDES
determination in argon in gas chromatography, electron drift velocity detector for, 18: 33476
determination in metals, vacuum fusion, 18: 33491
effects on vacuum gage operation, anomalous, 18: 33759 (AD-427830)
electron reactions at 1.7 to 3.5 ev, vibrational excitation in, 18: 34440
reactions with uranium tetrachloride, thermodynamics of, 18: 33530 (ORNL-TM-829)
yields in gamma radiolysis of liquid cyclohexanone, 18: 33623

CARBON STEEL
decontamination of, comparison of solutions for, 18: 35127(R) (GEAP-3771-13)
martensitic transformation in, effects of deformation and heat cycling on, 18: 34133 (UCRL-11388)

CARBON SYSTEMS
Al–C–Mo, superconducting transition of Mo_3Al_2C, 18: 34283 (UCRL-11390)
Al–C–Mo–Ni–Si–U–Zr, preparation and fabrication as refractory fuel material, 18: 34071(P)
Al–C–Nb, superconducting transitions in, 18: 34283 (UCRL-11390)
C–Au, sorptive properties for krypton-85 as bremsstrahlung source, 18: 34287(T) (NP-tr-1160)
C–Fe–Mo–Ni, corrosion of HyMu-80 in fluoride volatility process, 18: 34034(R) (BMI-1672(Del.))
C–Nb–Zr, phase studies on, 18: 34211
C–N–U, phase diagram and stability of, 18: 33576
C–Th–U, compatibility with Inconel and stainless steel, 18: 34034(R) (BMI-1672(Del.))

CARBONYL COMPOUNDS
yields in thymidine radiolysis, 18: 33658

CARCINOGENESIS
radioinduced *vs.* spontaneous incidence of, 18: 33299

CARCINOMAS
radiation effects on, pathologic study of, 18: 33296
radiotherapy of cervical, incidence of persistent or recurrent cancer, 18: 33444
radiotherapy of, effects of AET on, 18: 33407

CAROLINAS-VIRGINIA TUBE REACTOR
operation, Apr. 1 to June 15, 1964, 18: 35140(R) (CVNA-207)
operations, 18: 35153(R) (SRO-103)
vapor container leak rate tests, 18: 35141 (CVNA-208)

CASCADE SHOWERS
detection of, spark chamber efficiency for, 18: 33966
electrons in, mean square lateral deviations for, 18: 34487
theory, 18: 34476

CATALYSIS
book: *Advances in Catalysis and Related Subjects*, 18: 33453

CATION EXCHANGE MATERIALS
properties of Decalso for leach-resistant radiation sources, 18: 34007(R) (ORNL-TM-890)
radiation effects on exchange capacity of, neutron, 18: 35234(R) (HW-81862)

CATIONS
electron-transfer reactions in solution, mechanisms of, 18: 33521 (BNL-8081)

CATS
iodine-131 uptake by blood plasma, liver, muscles, renal organs, and skin of, 18: 33251
radiation effects on nervous system in, 18: 33278 (STI/DOC/10/28(p.39-66))

CATTLE
strontium-90 content in bones of, 18: 33240

CAVITATION
damage in liquid sodium, research program on, 18: 34075 (NASA-CR-54071)

CERAMIC MATERIALS
properties of refractory, handbook on, 18: 34129 (RTD-TDR-63-4102 (Suppl.1))
radiation and environmental effects in space, 18: 34235

CERIUM
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination in mixture with uranium using potassium dichromate, titrimetric, 18: 33496
determination in presence of manganese using TTA, spectrophotometric, 18: 33540
gamma attenuation at 0.1 to 10 Mev, coefficients for, 18: 35058
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
oxidation of iron complexes with dipyridine, 1,10-phenanthroline, and cyanides, electron-transfer reactions in, 18: 33550
reactions with oxalic acid in sulfuric acid media, effects of sodium sulfates on, 18: 33537
separation from heat conducting alloys and high-alloy steels, 18: 33504
separation from thorium and uranium by paper chromatography, 18: 33505
valences of allotropes of, anomalous, 18: 34280(R) (NYO-2680-1)

CERIUM ALLOYS
Al–Ce, production and properties of, 18: 34099
Cd–Ce, crystallization from liquid cadmium, precipitation of ternary addition with $CeCd_{11}$ in, 18: 34192
Ce–Fe, magnetic properties of Laves phase $CeFe_2$, 18: 34156
Ce–Th, lattice spacing measurements at 25 to 460°C, 18: 34161
Ce–Y, properties and structure of, 18: 34160

CERIUM ISOTOPES Ce-141
determination in fission products in presence of cerium-144, 18: 33465 (USNRDL-TR-756)
determination in liquids, gamma spectrometric, 18: 33485
determination in urine and feces of, gamma spectrometric, 18: 33264

CERIUM ISOTOPES Ce-144
content in United States wheat, 18: 33818
content of, in fish in Irish Sea, 18: 33248
determination in fission products in presence of cerium-141, 18: 33465 (USNRDL-TR-756)
determination in liquids, gamma spectrometric, 18: 33485
determination in urine and feces, gamma spectrometric, 18: 33264
determination of physico-chemical state in liquid media by paper electrophoresis and radioactivity recording, 18: 33590
effects of ingested, on growth and development of embryos in pregnant rats, 18: 33352
excretion by mice, effects of DTPA on, 18: 33417
gamma spectra of, least-squares analysis of, 18: 33926
metabolism of intratracheal injected, in rats, 18: 33252
preparation of Decalso glass sources of, 18: 34007(R) (ORNL-TM-890)
properties for use as heat source in direct conversion devices, 18: 34002
separation from Hanford wastes for use as heat sources, 18: 33983 (HW-SA-3080(Rev.))
sorption by river silts, 18: 35238 (STI/DOC/10/28(p.9-20))
use in radiochemistry and tracer techniques, optimum counting methods for, 18: 33655

CERIUM OXIDES
CeO_2–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
CeO_2–Ta_2O_5, properties and structure of compounds formed in, 18: 34199

CERIUM SELENIDES
electric properties and uses of, 18: 34158
reactions with gallium selenides, 18: 33552

CERIUM TELLURIDES
electric properties and uses of, 18: 34158

CESIUM
catalytic effects on radioinduced polymerization of solid 3,3-*bis*-chloromethyloxatane, 18: 33651
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination in rocks by flame photometry, 18: 33500
ion exchange equilibrium with phenol-sulfonic acid type resin in aqueous alkaline solutions, 18: 33449(R) (NIRS-2(p.15-19))
optical pumping in argon, helium, and neon, spin relaxation time in, 18: 33566
separation from cesium chloride by ion exchange, 18: 34006(R) (ORNL-TM-889)

CESIUM ALLOYS
Sb–Cs–K, performance as photocathode, 18: 33903

CESIUM CHLORIDES
spectra of cesium and lithium tellurides at 700°C in, absorption, 18: 35060(R) (ANL-6904)

CESIUM IODIDES
electron penetration effects in 4f level of, 18: 33579
polarization formula for ^2F series of, 18: 33580
scintillation processes in crystals of, 18: 33636

scintillation processes in thallium-activated, 18: 33636
CESIUM IONS
production of, using cesium plasma capillary emitter, 18: 34502
CESIUM ISOTOPES Cs-132
diagnostic use of, calibration methods for, 18: 34274(R) (NIRS-2 (p.3-15))
production of pure, 18: 34014(P)
CESIUM ISOTOPES Cs-133
gamma reactions (γ,n) at high energy, use for cesium-132 production, 18: 34014(P)
CESIUM ISOTOPES Cs-134
determination in man, by whole-body counting or analysis of urine, 18: 33265
CESIUM ISOTOPES Cs-137
content in blood samples collected in Japan, 1963, 18: 33263
content in human urine, 18: 33805(R) (NIRS-2(p.57-67))
content in milk and people in France, 1961–1964, 18: 33429
content in United States wheat, 18: 33818
content of, in fish in Irish Sea, 18: 33248
determination in human urine, radiochemical, 18: 33449(R) (NIRS-2 (p.15-19))
determination in liquids, gamma spectrometric, 18: 33485
determination in man, by whole-body counting or analysis of urine, 18: 33265
determination in urine and feces, gamma spectrometric, 18: 33264
determination in urine, 18: 33518
determination of physico-chemical state in liquid media, by paper electrophoresis and radioactivity recording, 18: 33590
fallout of, body burden contribution of, 18: 33805(R) (NIRS-2(p.57-67))
gamma spectra of, least-squares analysis of, 18: 33926
metabolism by plankton, 18: 35238 (STI/DOC/10/28(p.9-20))
metabolism of, by fish, 18: 35238 (STI/DOC/10/28(p.9-20))
preparation of Decalso glass sources of, 18: 34007(R) (ORNL-TM-890)
properties for use as heat source in direct conversion devices, 18: 34002
separation by electromigration, 18: 34006(R) (ORNL-TM-889)
separation from Hanford wastes for use as heat sources, 18: 33983 (HW-SA-3080(Rev.))
separation from sodium ion-containing wastes, process development, 18: 34006(R) (ORNL-TM-889)
uptake by above-ground plant parts of, from air, 18: 33235(T) (AEC-tr-6448)
uptake by Japanese vegetables from fallout, 18: 33805(R) (NIRS-2 (p.57-67))
uptake by muscles from fallout, 18: 33427
uptake by plants from soil and irrigation water, 18: 33239
use in level indicator for tower flooding analysis, 18: 34000
use in radiochemistry and tracer techniques, optimum counting methods for, 18: 33655
yields from fission of uranium-235, 18: 33678(R) (ANL-6875)
CESIUM TELLURIDES
spectra in cesium chloride at 700°C, absorption, 18: 35060(R) (ANL-6904)
CESIUM URANYL NITRATES
preparation and fluorescence spectra of di-, 18: 33547
CHARCOAL
particle sizing by automatic counter and sizer, 18: 34274(R) (NIRS-2 (p.3-15))
CHARGED PARTICLE BEAMS
coulomb scattering in focusing media, computer programs for, 18: 34368 (CERN-64-29)
interaction with electric fields, electric power generation by, 18: 34501
CHARGED PARTICLES
detection of, streamer chamber for, 18: 33965
diffusion in ionosphere, 18: 34678
distribution functions of systems of, in equilibrium, 18: 34415
distribution in auroral regions, 18: 34672
energy losses in plasma, 18: 34996
invariance of action integral for, in magnetic field, 18: 34293
motion in electromagnetic field, 18: 34638
motion in plasma, collective oscillations from, 18: 34982
time delay lines for, crossed-field, 18: 34277 (NP-14134)
transport in electric fields, equation for Brownian, 18: 34349
transport in plasma in strong magnetic field, 18: 35027
velocity measurements on, technique for, 18: 33977(P)
CHEMICAL ANALYSIS
book: *Analysis of High-Melting Compounds*, 18: 33474(T) (FTD-TT-63-814)
developments in ring oven technique, 18: 33497
of refractory materials, book, 18: 33474(T) (FTD-TT-63-814)
CHEMICAL ENGINEERING
bibliography on uses of less common metals for process equipment in, 18: 34151
CHEMICAL RADIATION DETECTORS
use of absorption in silver metaphosphate glass for high-level gamma dosimetry, 18: 33891(T) (ORNL-tr-216)
CHEMISTRY
activities of Soreq Research Establishment, Israel, 18: 33447 (IA-893)
book: *Isotopic and Cosmic Chemistry*, 18: 33456
book: *Mossbauer Effect and Its Application in Chemistry*, 18: 33604(T)
quantum, Monte Carlo evaluation of many-centered, polyelectronic integral matrices in, 18: 34423
CHERENKOV DETECTORS
properties for particle velocity analysis, 18: 33977(P)
CHERENKOV RADIATION
emission by electrons in extensive air showers, 18: 34488
emission in hydrogen, radiative corrections to, 18: 34258(R) (AD-417250)
intensity variations in cosmic showers, 18: 34489
CHICKENS
iodine-131 uptake by blood plasma, liver, muscles, renal organs, and skin of, 18: 33251
iodine-131 uptake by eggs from, 18: 33255
radiation effects on embryonic cells of, gamma, 18: 33271(R) (NIRS-2 (p.26-31))
CHIMERAS
radiation effects on immune reactions in rat, 18: 33387
CHINON REACTORS (EDF-1)
concrete shield for, steel framework for top, 18: 35167
CHINON REACTORS (EDF-3)
data processing, 18: 34017
CHLORIDE COMPLEXES
with americium, neptunium, and plutonium in solutions, spectrophotometric and ion exchange studies, 18: 33526 (IA-924)
CHLORIDES
properties of mixed metallic, in molten salt reactors, 18: 34050(R) (ORNL-3626(p.59-164))
CHLORINE
effects on chemical equilibrium and rate of solvation of charge groups in aromatic compounds, 18: 33613
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
radiolysis effects on hydrogen formation in gaseous hydrochloric acid, 18: 33625
CHLORINE FLUORIDES
review of properties of tri-, 18: 33522 (CEA-2360)
CHLORINE ISOTOPES
separation in calutrons, 18: 34007(R) (ORNL-TM-890)
CHLORINE ISOTOPES Cl-35
nuclear quadrupole coupling in sodium chlorate, Stark effects on, 18: 34301
CHLORINE ISOTOPES Cl-37
Auger group intensities in, K, 18: 34789
CHLORINE SYSTEMS
Cl–$PbCl_2$, solvent properties for clad fuel elements, effects of copper on, 18: 33691(P)
CHLOROFORM
chloroform–cupferron, solvent properties for iron and titanium, 18: 33540
CHLOROPLASTS
quantum conversion in, 18: 33218
CHOLINE
radiation effects on reaction to, in mice, 18: 33368
CHOLINE, ACETYL-
radiation effects on content in rat brain, effects of aminazine on, 18: 33325
CHOLINESTERASES
radiation effects on activity of, in rats, 18: 33306
CHROMATOGRAPHIC SEPARATIONS
of peptides from irradiated ovalbumin, 18: 33499
CHROMATOGRAPHY
analysis of radiochromatograms, instrument for, 18: 33490
development of gas, 18: 33678(R) (ANL-6875)
gas, electron drift velocity detector for, 18: 33476
recording uv light absorption spots in paper, 18: 33449(R) (NIRS-2(p.15-19))
CHROMIUM
activation by thermal neutrons, self-shielding effects in, 18: 33488
bibliography on preparation, fabrication, and uses of, 18: 34151
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
contents in meteorites, 18: 34398
deposition on D-14 niobium alloy, 18: 34052 (RTD-TDR-63-4063)
determination in MSRE fuel salts, 18: 34050(R) (ORNL-3626(p.59-164))
determination in silicon, activation, 18: 33502

determination of traces of, in water by atomic absorption spectrometry, 18: 33461 (DP-879)
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
gamma reactions (γ,n) with, neutron angular distribution from, 18: 34935
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
tensile properties of, effects of interaction of interstitial solute and substructure on, 18: 34204
x-ray spectra of, precision redetermination of wavelength of $K\alpha_1$ line in, 18: 34341

CHROMIUM ALLOYS
Cr–Fe, phase studies based on thermochemical data, 18: 33603
Cr–Mo, phase studies based on thermochemical data, 18: 33603
Cr–Mo–Nb, oxidation at 800 to 1200°C, 18: 34080
Cr–Ni, lubrication by fused fluoride coatings in air, hydrogen, liquid sodium, and vacuum, 18: 33695 (NASA-TN-D-2348)
Cr–Re, nitrogen interstitials in, internal-friction studies of, 18: 34032(R) (BMI-1668(Del.))
Cr–Re, nitrogen interstitials in, internal-friction studies of, 18: 34034(R) (BMI-1672(Del.))
Cr–Re, nitrogen interstitials in, internal-friction studies of, 18: 34033(R) (BMI-1669(Del.))

CHROMIUM BROMIDES
bromine-79 and -81 NMR in, 18: 33584

CHROMIUM IONS
polymerization of trivalent, in aqueous solutions, 18: 35255 (UCRL-11410)

CHROMIUM ISOTOPES Cr-50
proton reactions (p,γ) with, 18: 34793

CHROMIUM ISOTOPES Cr-51
separation from ammonium citrate and alkaline permanganate wastes by precipitation and ion exchange, 18: 35235 (IDO-12036)

CHROMIUM ISOTOPES Cr-52
energy levels, 18: 34855
proton reactions (p,γ) with, 18: 34797

CHROMIUM ISOTOPES Cr-54
proton reactions (p,α) at 11 to 12.5 Mev, 18: 34855

CHROMIUM STEEL
corrosion by flowing sodium, 18: 34073(R) (GEAP-4438)
Cr–Mo, corrosion by flowing sodium, 18: 34073(R) (GEAP-4438)

CHROMIUM SYSTEMS
Al–Cr–Si, coating processes for cementation on refractory metals, 18: 34091
Cr–Si–Ti, coating processes for cementation on refractory metals, 18: 34091

CHROMOSOMES
aberrations induced by ethyleneimine and triethylene melamine, mechanism of, 18: 33271(R) (NIRS-2(p.26-31))
aberrations induced in mice by nucleic acids and radiation, comparison of, 18: 33309
diseases of, in human populations, effects of hereditary factors and radiation on, 18: 33336
effects of 4-nitro-1-oxide on Drosophila, 18: 33273(R) (NIRS-2(p.42-8))
radiation effects on telophase, microbeam, 18: 33271(R) (NIRS-2(p.26-31))
radiation effects on tritium-labeled *Vicia faba*, x, 18: 33318
radiation effects on sister chromatid exchange in, of hamster cells in culture, 18: 33329
radiation effects on human, x, 18: 33334
radiation effects on mitotic plant cell, 18: 33372
radiation effects on Drosophila X, gamma, 18: 33378
radioinduced aberrations of , 18: 33231(R) (NIRS-2(p.49-56))
radioinduced polyploidy in Chinese hamster cell, x, 18: 33383
uptake of tritiated thymidine, 18: 33253

CIRCUITS
design and development of, summary, 18: 34752(R) (CU(PNPL)-234)
design of alarm trip, for use with microammeters of ionization chambers, 18: 33826 (DP-897)
design of recording and print out, for gamma scanner data recording system, 18: 33232(R) (NYO-910-3)
development and testing of switchgear for space uses, 18: 33828(R) (NASA-CR-54059)
development of high-stability, modular, for multiple semiconductor detector systems, 18: 33936
performance of radiation-resistant magnetic amplifier control, under fast-neutron and gamma irradiation, 18: 33825 (AD-435095)
radiation effects on circuit boards, 18: 33838 (RTD-TDR-63-4287 (Vol.I))
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))

CIRCULATORY DISEASES
of brain, tracer techniques for diagnosis, 18: 33441

CIVILIAN DEFENSE
measures in nuclear warfare, 18: 33814

CLAYS
water content in leda, calibration of neutron meter for measuring, 18: 33897

CLOUD CHAMBERS
operation of, with low helium pressures, 18: 33942

CLOUDS
release from point source, measurement by sampling array, 18: 33803 (LA-3094)

COAL
analysis for ash by x-ray absorption, continuous, 18: 33467(T) (AEC-tr-6399(p.51-60))

COATINGS
deposition of oxidation-resistant refractory, 18: 34116(P)
development for fuel particles, 18: 34032(R) (BMI-1668(Del.))
development for fuel particles, 18: 34033(R) (BMI-1669(Del.))
development for oxidation protection of D-14 niobium alloy, 18: 34052 (RTD-TDR-63-4063)
development of refractory metal, for earth re-entry systems, 18: 34209
for graphite protection at high temperatures, review, 18: 34043 (ML-TDR-64-173(Pt.I))
properties of fuel-element, in steam and water in-pile, 18: 34076 (TID-8540(p.213-330))
radiation effects on, handbook on, 18: 34245

COAXIAL CABLES
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))

COBALT
activation by thermal neutrons, self-shielding effects in, 18: 33488
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
contents in meteorites, 18: 34398
determination in silicon, activation, 18: 33502
determination of traces of, in water by atomic absorption spectrometry, 18: 33461 (DP-879)
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
effects on growth and nitrogen fixation in Nostoc, 18: 33237
effects on sintering rates of tungsten, 18: 34098
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
radiodermatitis effects on content of, in skin and blood, 18: 33285(T) (JPRS-25502)
separation from thorium and uranium by paper chromatography, 18: 33505
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685

COBALT ALLOYS
Co–Nb, crystal structure of beta phase of, 18: 34145
Co–Nb, solvent properties for silicon in beta phase of, 18: 34145
Co–Ti, magnetic moments and superconductivity of, 18: 34700

COBALT ISOTOPES Co-55
energy levels, 18: 34855

COBALT ISOTOPES Co-57
decay scheme from iron-56 (p,γ) reactions, 18: 34792
incorporation in EDTA, tracer study using, 18: 33231(R) (NIRS-2(p.49-56))

COBALT ISOTOPES Co-59
deuteron reactions (d,p) with, 18: 34827
neutron reactions (n,γ) with, 18: 34827
proton reactions (p,n) at 7 to 13 Mev, 18: 34859

COBALT ISOTOPES Co-60
beta decay of, angular correlations in, 18: 34752(R) (CU(PNPL)-234)
energy levels, 18: 34827
gamma dose distribution calculations from rotational teletherapy source of, 18: 33445
neutron self-shielding factor of foil of, 18: 34737
properties for use as heat source in direct conversion devices, 18: 34002
separation from ammonium citrate and alkaline permanganate wastes by precipitation and ion exchange, 18: 35235 (IDO-12036)
use for measuring water flow rate through heat exchangers, 18: 33750

COBALT SYSTEMS
Co–WC, grinding, 18: 34095

COINCIDENCE CIRCUITS
design and development of, summary, 18: 34752(R) (CU(PNPL)-234)

COINCIDENCE COUNTERS
description of azimuthal small solid-angle telescope, 18: 33888(T) (NASA-TT-F-126(p.138-60))
description of IGY standard cubical telescope, 18: 33887(T) (NASA-TT-F-126(p.102-37))
design, 18: 33950
design of orbiting x-ray telescope, proposal for, 18: 33970
design of 4π beta, for low activities, 18: 33943
COINCIDENCE MEASUREMENTS
equipment and methods for lifetimes of nuclear excited states, 18: 34772 (NP-14184)
geometrical corrections in triple, 18: 33952
method for lifetimes of radioelement-daughter isomers, 18: 34770 (NP-14115)
COKE
analysis for ash by x-ray absorption, continuous, 18: 33467(T) (AEC-tr-6399(p.51-60))
manufacture, gamma-ray system for automatic operation of delivery machines used in, 18: 33987(T) (AEC-tr-6399(p.202-6))
COLCHICINE
mutagenic effects on barley seeds, 18: 33375
COLLAGEN
deuterium oxide effects on rat, 18: 33250
COLLIMATORS
response of, to moving point source of radiation, 18: 33969
COLLOIDS
electron spin resonance of potassium, in irradiated potassium azide, 18: 33647
radiation effects on, effects of oxygen, 18: 33283(R) (TID-20889)
COLORADO PLATEAU
origin of uranium ores on, lead–uranium isotopic ages measurement for evidence on, 18: 33796
COMETS
chemical properties, 18: 34402
COMMUNICATION SYSTEMS
electric power system for SYNCOM 2 satellite, 18: 33700
specifications of radio equipment for fallout shelters, 18: 33840 (TGGM-642)
COMPUTER PROGRAMS
AIREK and AISITE, for reactor safety studies, 18: 35247(R) (NAA-SR-9700)
BIGG-I, multigroup neutron spectra and criticality code for Ferranti Mercury, 18: 34730 (KR-77)
B51 and B58 of CERN Series W101, for coulomb scattering in focusing media, FORTRAN for IBM 709, 18: 34368 (CERN-64-29)
description of, for fast ceramic reactor kinetics analyses, 18: 35146(R) (GEAP-4601)
development for optical lens design, for IBM 7090, 18: 35245 (LADC-6205)
Empire-1 and -2, for neutron transport in slab geometries, 18: 34732 (WAPD-TM-436)
EPITHERMOS, epithermal neutron spectra in light-water-moderated reactors, 18: 35128(R) (GEAP-4642)
for evaluation of performance of scintillation detectors, 18: 33232(R) (NYO-910-3)
for fluid flow and thermal analysis of NERVA systems, 18: 33751
for reactor autocorrelation and power spectral density, 18: 35077 (TID-7679(p.301-5))
GANDS, for extraction of Westcott factors from RBU tape, FORTRAN II for IBM 7090, 18: 34015 (HW-81117(Rev.1))
magnetic field mapping using Benson-Lehner plotter, FORTRAN for IBM 7030, 18: 34266 (CLM-R-31)
plasma stability in magnetic mirrors, FORTRAN for IBM 7030, 18: 34266 (CLM-R-31)
STAT-3, for operations on matrices, 18: 35244 (KAPL-M-6165)
SYRIO, for matrix inversion, for UNIVAC-UCT(SS-90), 18: 34016 (IEN-122-DF/I-38)
TATAR, neutron parameters for heavy-water lattices, ALGOL-60 for GIER, 18: 35112 (RISÖ-81)
TOPIC, for neutron transport in cylindrical geometry, FORTRAN for IBM 7090/40, 18: 34729 (IDO-16968)
TRG–SGD, for calculating secondary gamma dose from nuclear weapon explosion, 18: 34285 (WL-TDR-64-46(Vol.I))
COMPUTERS
development for analyses of biological hazards of space radiation, IBM 7090 FORTRAN, 18: 35048 (AMRL-TDR-64-11)
programming for analysis of nuclear reactions, 18: 34752(R) (CU(PNPL)-234)
use for bubble chamber photograph scanning and measuring, 18: 33957
use in automatic system for nuclear activation analysis, 18: 33464 (NASA-CR-52997)
use in control of multiple neutron spectrometers, 18: 33876 (BNL-8180)
use in multiparameter nuclear experiments for display-oriented data simulation and analysis, 18: 34366 (BNL-8166)
use in neutron time-of-flight spectrometer data processing systems, 18: 33958
use in patient simulation for planning radiotherapy of tumors, 18: 33435
use in radiation dose calculations for radiotherapy of tumors, 18: 33434
CONCRETES
fabrication of prestressed, for pressure vessels, 18: 35196
gamma attenuation at 0.1 to 10 Mev, coefficients for, 18: 35058
gamma dose rate in blockhouse of, from ground sources, 18: 35055
gamma transmission through slabs of, 18: 35051
properties as reactor biological shields, 18: 35092(T) (JPRS-25467 (p.1-8))
CONDENSATION
theory of irreversible, for general vapors, 18: 34323
CONDENSERS
development for nuclear space propulsion systems, 18: 35216
CONES
magnetic fields from current-sheet, Legendre polynomial evaluation of, 18: 34273 (NASA-TN-D-2400)
CONFERENCES
Noise Analysis in Nuclear Systems, 4th AEC Symposium Series, Gainesville, Fla., Nov. 4–6, 1963, 18: 35069 (TID-7679)
Radioisotopic Methods for Automatic Control, Kirgizskoi, SSR, June 1961, 18: 33986(T) (AEC-tr-6399)
Refractory Composites Working Group, Eighth Meeting of, Fort Worth, Texas, Jan. 14–16, 1964, 18: 34037 (DMIC-Memo-192)
Refractory Metals, AGARD Conference on, Oslo, Norway, June 23 to 26, 1963, 18: 34068
Scintillation and Semiconductor Counter Symposium, Ninth, Wash. D. C., Feb. 1964, 18: 33900
CONNECTIVE TISSUE
radiation effects on rat, 18: 33277 (STI/DOC/10/28(p.21-38))
CONNECTORS (ELECTRIC)
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
CONTAMINATION
determination of internal, by radiochemical urine analysis, 18: 33519
of atmosphere from point source, measurement by sampling array, 18: 33803 (LA-3094)
CONVECTION
boiling burnout studies, 18: 33737 (ORNL-P-18)
CONVERSION ELECTRONS
spectra of, from beta decay of tungsten-187, 18: 34804
COPPER
activation by thermal neutrons, self-shielding effects in, 18: 33488
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
beta scattering by, measurement of saturation backscattering from, 18: 35057
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
content in normal and leukemic leukocytes, activation analysis of, 18: 33517
contents in meteorites, 18: 34398
copper-64 beta decay in infinite medium of, positron spectral distribution from, 18: 34904
crystal structure of, acoustic attenuation study of friction on fast moving dislocations in, 18: 34276 (NP-14129)
determination in pure uranium compounds by solvent extraction using dithizone, 18: 33509
determination in silicon, activation, 18: 33502
determination of traces of, in water by atomic absorption spectrometry, 18: 33461 (DP-879)
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
effects on dissolution of clad fuel elements in molten chlorine–lead chloride, 18: 33691(P)
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
effects on radiation damage in silicon crystals, 18: 34228
effects on sintering rates of tungsten, 18: 34098
electron reactions at 1 and 4 Bev, proton production in, 18: 34916
electron scattering by, energy loss mechanisms in relativistic, 18: 34258(R) (AD-417250)
gallium atom ranges at low energies in, 18: 34441
gamma coherent scattering at small angles, 18: 35053
gamma reactions (γ,n) with, neutron angular distribution from, 18: 34935
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))

properties of nickel-coated tubes of, for transmitting neutrons, 18: 34752(R) (CU(PNPL)-234)
proton scattering at 93 to 193 kev, angular distributions for, 18: 34943
radiation effects on, recovery spectrum from electron, 18: 35247(R) (NAA-SR-9700)
radiodermatitis effects on content of, in skin and blood, 18: 33285(T) (JPRS-25502)
separation from zirconium by ion exchange on pyrocatechol-*O,O*-diacetic acid, 18: 33508
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
stored energy release in, 18: 34122(R) (GA-4900)
surface properties for molten chloride and fluoride salts, 18: 34050(R) (ORNL-3626(p.59-164))
x-ray emission, tensity of Kα, 18: 33896
x-ray spectra of, precision redetermination of wavelength of $K\alpha_1$ line in, 18: 34341

COPPER ALLOYS
Be–Cu, alpha reactions with, secondary electron emission from, 18: 33911
Be–Cu, electron multiple emissions from, 18: 34450
Be–Cu, welding of heavy plates of, 18: 34111
Cu–Mn, crystal structure of, acoustic attenuation study of friction on fast moving dislocations in, 18: 34276 (NP-14129)
Cu–Zr, embrittlement effects of hydrogen on, 18: 34169

COPPER IONS
binding to bovine serum albumin-stabilized emulsions, 18: 33575

COPPER ISOTOPES Cu-63
proton inelastic scattering at 7 to 11 Mev, in excited-core model, 18: 34862

COPPER ISOTOPES Cu-64
beta decay in infinite copper medium, positron spectral distribution from, 18: 34904
positron emission, diagnostic use of, after differential uptake by brain tumors, 18: 33432

COPPER ISOTOPES Cu-65
proton reactions (p,n) at 7 to 13 Mev, 18: 34859

COPPER MINERALS
Cu–Ni, sulfur-34 content in sulfides from Soviet Union deposits of, 18: 33767

CORROSION
bibliography on radiation effects on, 18: 34036 (CEA-Bib-16)
radiation effects on, bibliography, 18: 34036 (CEA-Bib-16)
review of fuel-element-cladding, 18: 34076 (TID-8540(p.213-330))

CORROSION INHIBITORS
use of acid phosphate and chromate as, in reactor cooling water circuits, 18: 35063 (IG-Report-52)

CORTICOSTEROIDS
excretion in irradiated cervical carcinoma, 18: 33287

CORTISONE
effects on phosphatide content and metabolism in irradiated and normal rat testes, 18: 33256
leukemogenic effects on mice, 18: 33311
radiosensitivity effects on animals after adrenalectomy, 18: 33404

COSMIC ALPHA PARTICLES
energy spectra of, modulation effects in, 18: 34482
flux of, during solar flare of Nov. 12 and 13, 1960, 18: 34389
intensity and modulation of primary, at low rigidities, 18: 34477
interactions in nuclear emulsion, secondary particle production in, 18: 34492

COSMIC ELECTRONS
Cherenkov emission from, in extensive air showers, 18: 34488
effects on manned space flight, computer analyses of, 18: 35048 (AMRL-TDR-64-11)
intensity beyond magnetospheric boundary, with energies >30 kev, 18: 34680
intensity over North America at 880 to 1010 km, 18: 34493
intensity variations of precipitated and trapped, diurnal, 18: 34480
precipitation of, electron-positron ratio in, 18: 34479

COSMIC MESONS
decay of (K), meson (μ) production in, 18: 34490
production by primary nucleons in atmosphere, 18: 34485

COSMIC MESONS (μ)
detection of, development of plastic scintillators for, 18: 33889(T) (NASA-TT-F-126(p.161-76))
polarization at 0.14 to 2.0 Bev, 18: 34490
production at sea level, coupling coefficients for conversion to primary particles, 18: 34471(T) (NASA-TT-F-126(p.265-72))
production in atmosphere, integral multiplicity calculations for, 18: 34470(T) (NASA-TT-F-126(p.230-64))
shower contributions to ionization bursts in dense materials near sea level, 18: 34474(T) (NASA-TT-F-126(p.286-91))

COSMIC MESONS (π)
decay of, meson (μ) production in, 18: 34490

COSMIC NEUTRINOS
theory, 18: 34598

COSMIC NEUTRONS
albedo flux of, in polar orbits, 18: 34478
detection and measurement at ground level, atmospheric temperature effects on, 18: 34469(T) (NASA-TT-F-126(p.224-9))
intensity variations of, barometric corrections for, 18: 34467(T) (NASA-TT-F-126(p.215-19))
interactions in nuclear emulsion, secondary particle production in, 18: 34492

COSMIC NUCLEONS
propagation in atmosphere, meson production in, 18: 34485

COSMIC PARTICLES
density distributions of charged, in EAS, 18: 34484
detection of solar flare-produced hydrogen isotopes, 18: 34382 (NP-14141)
effects on materials in space, 18: 34235

COSMIC PROTONS
effects on manned space flight, computer analyses of, 18: 35048 (AMRL-TDR-64-11)
energy spectra of, over Canada, 18: 34481
energy spectra of, modulation effects in, 18: 34482
geophysical effects of solar, 18: 34388
intensity and modulation of primary, at low rigidities, 18: 34477
intensity over North America at 880 to 1010 km, 18: 34493
interactions in nuclear emulsion, secondary particle production in, 18: 34492

COSMIC RADIATION
biological effects, 18: 33354
composition of galactic and metagalactic, 18: 34491
composition of primary, from Cherenkov flash variations, 18: 34489
coupling coefficients for, primary-secondary, 18: 34471(T) (NASA-TT-F-126(p.265-72))
coupling coefficients for, effects of solar activity on primary-secondary, 18: 34472(T) (NASA-TT-F-126(p.273-9))
detection and measurement at 9 to 12 km, all-components device for, 18: 34464(T) (NASA-TT-F-126(p.180-6))
detection and measurement below ground, meteorological effects on data from, 18: 34468(T) (NASA-TT-F-126(p.220-3))
detection and measurement of hard component at ground level, atmospheric temperature effects on, 18: 34469(T) (NASA-TT-F-126(p.224-9))
detection and measurement of, counter telescope for, 18: 33887(T) (NASA-TT-F-126(p.102-37))
detection and measurement of, counter telescope for, 18: 33888(T) (NASA-TT-F-126(p.138-60))
detection and measurement using plastic scintillators, 18: 33889(T) (NASA-TT-F-126(p.161-76))
detection and measurement of, radiosonde design for, 18: 33890(T) (NASA-TT-F-126(p.177-9))
detection and measurement of x radiation in, orbiting telescope for, 18: 33970
effects on manned space flight, computer analyses of, 18: 35048 (AMRL-TDR-64-11)
effects on materials in space, 18: 34235
energy of galactic and metagalactic, spectra of, 18: 34491
geomagnetic cutoff in, 18: 34477
hazards during space flight, 18: 33354
intensity data for, pressure and temperature corrections for, 18: 34468(T) (NASA-TT-F-126(p.194-214))
intensity variations of, causes of, 18: 34462(T) (NASA-TT-F-126(p.2-80))
intensity variations of, in relation to observations made at a single location, 18: 34463(T) (NASA-TT-F-126(p.81-101))
intensity variations during and after sudden-commencement geomagnetic storms, 18: 34465(T) (NASA-TT-F-126(p.187-93))
origin of, extragalactic, 18: 34486
spectra of primary, charge and energy, 18: 34481
x-ray spectrum at 37 to 700-kev over Minneapolis, 18: 34479

COSMIC SHOWERS
bubble chamber evaluation of contributions to ionization burst frequency from, 18: 34474(T) (NASA-TT-F-126(p.286-91))
charged-particle density distribution in extensive, 18: 34484
Cherenkov emission from electrons in, 18: 34488
electrons in, mean square lateral deviations for, 18: 34487
occurrence frequency of extensive, geometric corrections to barometric effects analyses of, 18: 34473(T) (NASA-TT-F-126(p.280-5))
structure of extensive, 18: 34483
theory of extensive, 18: 34476
time distributions of extensive, for small time intervals, 18: 34475(T) (NASA-TT-F-126(p.292-4))

COSMOLOGY
book: *Isotopic and Cosmic Chemistry*, 18: 33456
element synthesis in solar system, 18: 34274(R) (NIRS-2(p.3-15))
COTTON
radiation effects in seeds of, 18: 33313
radiation effects on seed, gamma, 18: 33333
COUNTING DEVICES
design of dosing system for radiometric automatic control device, 18: 33851(T) (AEC-tr-6399(p.177-85))
design of 4π beta, for low activities, 18: 33943
CREEP
equipment for measuring biaxial, for materials in lithium at temperatures up to 2500°F, 18: 34030 (APL-TDR-64-73)
CRITICAL ASSEMBLIES
experiments in ZPR-III, -VI, and -IX, May 1964, 18: 35060(R) (ANL-6904)
measurements in High-Conversion Facility, 18: 35060(R) (ANL-6904)
neutron lifetimes in cylindrical enriched-uranium, prompt, 18: 34496
noise analyses of Japanese, 18: 35073 (TID-7679(p.155-69))
physics measurements for water-moderated slightly enriched, 18: 35113 (TID-8540(p.529-609))
prompt neutron lifetimes of bare and reflected ZPR-III, 18: 35060(R) (ANL-6904)
reactivity measurements for Westinghouse CES, noise techniques in, 18: 35072 (TID-7679(p.135-54))
CRITICALITY STUDIES
computer program for homogeneous-lattice, 18: 34730 (KR-77)
control rod mockups of RAPSODIE in ZPR-III, 18: 35060(R) (ANL-6904)
neutron surface multiplication for shielded containers, calculation of, 18: 34726 (AWRE-O-21/64)
of annular cylinders containing plutonium solutions, 18: 34494 (CEA-R-2495)
sodium-void coefficient studies in ZPR-VI, 18: 35060(R) (ANL-6904)
temperature coefficients in, transport-theory calculation of, 18: 35118
CROSS SECTIONS
fluctuations in regions of overlapping compound nuclear states in terms of density of single-nucleon states, 18: 34893
quantum corrections to transport, 18: 34650
CRUSTACEA
embryonic development in Artemia, 18: 33271(R) (NIRS-2(p.26-31))
radiation effects on eggs of Artemia, comparison with antibiotics and high temperature, 18: 33271(R) (NIRS-2(p.26-31))
radiation effects on encysted dry eggs of Artemia, fractionated-dose, 18: 33272(R) (NIRS-2(p.31-42))
CRYOGENICS
refrigeration cycles for cryogenic magnets, 18: 34682(R) (NBS-8407)
seals for, 18: 34685
systems for Cambridge Synchrotron, 18: 34367 (CEAL-1000)
CRYSTAL STRUCTURE
book: *Phonons and Phonon Interactions*, 18: 34451
calculations on, inversion of overlap matrix for, 18: 34019
dislocation motion in, acoustic attenuation study of, 18: 34276 (NP-14129)
electron-phonon interactions in, theory for, 18: 34453
integral equations for classical fluids and lattice gas, 18: 34336
CRYSTALS
dislocation mobilities in bcc, 18: 34039(R) (GA-5340)
neutron inelastic scattering by anharmonic, scattering function for, 18: 34460
neutron inelastic scattering by anharmonic, functions for, 18: 34748
neutron scattering by, 18: 34455
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
x-ray diffraction by perfect, dynamical theory of, 18: 34354
x-ray scattering by, theory for, 18: 34452
CUPFERRON
chloroform–cupferron, solvent properties for iron and titanium, 18: 33540
use in rare-earth subgroup separation, 18: 33689
CURIUM
separation from ammonium nitrate solutions by solvent extraction using trioctylphosphine oxide, 18: 33686
separation from nitric acid solutions by solvent extraction using tri-octylphosphine oxide, 18: 33686
CURIUM ISOTOPES Cm-242
properties for use as heat source in direct conversion devices, 18: 34002
CURIUM ISOTOPES Cm-244
fission of, alpha spectra in spontaneous ternary, 18: 34955
fission products of, ionization in argon–methane by, 18: 33895
properties for use as heat source in direct conversion devices, 18: 34002
CYCLOHEPTATRIENE
7-methoxy, appearance potentials and energies in electron dissociation of, 18: 33627
CYCLOHEXANE
cyclohexane–TBP, solvent properties for uranium from aqueous solutions, 18: 33681 (JEN-138-DQ/I-42)
CYCLOHEXANOL
yields in gamma radiolysis of liquid cyclohexanone, 18: 33623
CYCLOHEXANONES
methyl-, radiolysis, effects of uranyl nitrate and water on gamma, 18: 33621 (UJV-977/64)
radiolysis of liquid yields in gamma, 18: 33623
radiolysis of liquid, effects of benzene and 2,3-dimethyl-1,3-butadiene on gamma, 18: 33624
solvent properties for rare earths, 18: 33689
CYCLONE SEPARATORS
design and development of centrifugal, for air-water and steam-water systems, 18: 33693(R) (ACNP-64026)
CYCLOTRON RADIATION
emission from Penning discharge in higher harmonics, 18: 34362
CYCLOTRONS
data analysis system for, 18: 34366 (BNL-8166)
deuteron acceleration in sector-focused, resonant depolarization in, 18: 34378
CYLINDERS
criticality studies of plutonium solutions in annular, 18: 34494 (CEA-R-2495)
fluid flow around rectangular, dynamics and heat transfer in von Kármán wake of, 18: 33748
gamma transmission through shielding, Monte Carlo calculations for, 18: 35052
temperature distribution and thermal stresses in radiation-cooled solid, 18: 33740 (SC-DC-64-891)
CYTOLOGY
photometric techniques for, 18: 33234 (UCRL-11459)
radiation effects on sister chromatid exchange in chromosomes of hamster cells in culture, 18: 33329
CZECHOSLOVAKIA
strontium-90 content in fallout and soil in Western Slovakia in, 18: 33776

D

DATA RECORDING SYSTEMS
design and uses of multiparameter, 18: 33859
design of four-channel, with paper tape output, 18: 33837 (RT/EL(64)-8)
design of transistorized analog-to-digital convertor, 18: 33873(P)
design of, for use with whole-body gamma scanner, 18: 33232(R) (NYO-910-3)
development of, for visualization of isotope distribution on colored scintigrams, 18: 33968
DATA TABULATIONS
beta transitions, once-forbidden, 18: 34957(T)
dimensional stability of metals and alloys, 18: 34121 (DMIC-Memo-189)
electron spectra, low-energy, 18: 34786
energies of K electron levels for $z = 5$ to 24, 18: 34414
gamma attenuation coefficients for shielding materials, 18: 35058
gamma spectra for 300 radioisotopes, 18: 34755 (IDO-16880-1)
gamma spectra for 300 isotopes, 18: 34756 (IDO-16880-2)
geomagnetic and solar activity parameters, 18: 34391
neutron activation analysis parameters, 18: 33492
neutron reactions (n,α) with nuclei at 14 Mev, total cross sections for, 18: 34887
neutron removal cross sections, fast, 18: 34888
nuclear binding energies, 18: 34812
nuclear space propulsion performance parameters, 18: 35216
on neutron reactions (n,α), 18: 34810
phase diagrams and properties of plutonium alloys and systems, 18: 34125 (KFK-220)
power systems performance parameters, space, 18: 34001
properties of chlorine trifluoride, 18: 33522 (CEA-2360)
properties of refractory ceramics, 18: 34129 (RTD-TDR-63-4102(Suppl.1))
DECONTAMINATING SOLUTIONS
performance for carbon and stainless steels, 18: 35127(R) (GEAP-3771-13)
DECONTAMINATION
methods for skin, 18: 33812
DECONTAMINATION OF EQUIPMENT
equipment used by Euratom, 18: 33800 (EUR-1821.f)
DELAY LINES
bandwidth limitations of crossed-field charged-particle, 18: 34277 (NP-

14134)
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))

DENSITOMETERS
description of beta, for analysis of binary liquids, 18: 33473(T) (AEC-tr-6399(p.115-23))
description of vacuum automatic, 18: 34131 (TID-20849)
design of radiometric, for pulps and solutions in pipes, 18: 33848(T) (AEC-tr-6399(p.138-52))
radiation source calculations for gamma-absorption determination of pulp density, 18: 33847(T) (AEC-tr-6399(p.124-37))
radiometric, applications in building-materials industry, 18: 33852(T) (AEC-tr-6399(p.196-201))
radiometric, use of scintillation detectors with light ducts in, 18: 33850(T) (AEC-tr-6399(p.163-72))

DETONATION WAVES
propagation in conducting fluids in magnetic fields, 18: 34329
propagation through ideal gas, pseudosimilar and self-similar solutions for, 18: 34318
reflection by gases, 18: 34324

DEUTERIUM
burnout in steady-state plasma of, 18: 35014
content in rhyolitic lava, 18: 33788
determination in organic compounds by activation methods using carbon-14 (d,n) reaction, 18: 33486
deuteron reactions with mesic atoms of, yields in, 18: 34617
deuteron reactions (d,n) with, neutron polarization in, 18: 34963
deuteron reactions (d,n) and (d,p) at 25 Mev, differential cross sections for, 18: 34771 (NP-14175)
deuteron reactions at 25 to 500 kev, anisotropy factors for neutron yield in, 18: 34815
exchange with hydrogen, development of equipment for studying, 18: 34282(R) (TID-20837)
exchange with hydrogen in organic compounds, potential-energy surfaces in, 18: 33573
hydromagnetic wave motion in cylinder of, radial dependence of, 18: 35009
isotope effects in substitution reactions of methyl iodide, calculated, 18: 33612 (BNL-8066)
isotope exchange with water, poisoning of platinum–carbon catalyst during, 18: 33527 (IFA-28-IS)
magnetic moment and susceptibility of molecular, centrifugal and vibrational effects of rotational, 18: 34436
nuclear magnetic resonance of solid, at 1.5 to 4.2°K under high pressures, 18: 34260(AD-601933)
ortho-para conversion in solid, 18: 34260 (AD-601933)
photoabsorption and photoionization cross sections of, from 580 to 1000 Å, 18: 34421
separation from hydrogen, bibliography on, 18: 34008 (TID-3091 (Suppl.1))

DEUTERIUM IONS
reactions with ethylene molecules at 200 and 400 kev, mass spectra of fragments from, 18: 34433
vibrations of negative, in calcium fluoride, 18: 34262 (AFCRL-64-284)

DEUTERIUM SYSTEMS
D–H, magnetic moment and susceptibility of molecular, 18: 34436

DEUTERONS
acceleration in sector-focused cyclotron, resonant depolarization in, 18: 34378
angular distribution from calcium-40 (p,d) reactions at 55 Mev, 18: 34757 (INSJ-72)
emission in oxygen-16 reactions with nuclei at 167 Mev, spectra of, 18: 34780 (UCRL-11349)
interactions of, amplitudes for, 18: 34619
interactions with nucleons, amplitudes for break-up, 18: 34535
interactions with nucleons at 32 and 40 Mev, impulse approximation for elastic, 18: 34537
interactions with nucleons, helium-3 production in, 18: 34544
interactions with deuterons, helium-3 production in, 18: 34544
interactions with protons at 40 Mev, proton polarization in elastic, 18: 34550
interactions with electrons, wave function dependence of cross section for inelastic, 18: 34555
interactions with protons at 6.2 Bev, differential cross sections for elastic, 18: 34616
interactions with deuterons, meson (μ^-) catalysis of, 18: 34617
interactions with nucleons, optical theorem for, 18: 34618
interactions with mesons (π^-) at zero-energy, branching ratios and cross sections for, 18: 34634
interactions with antineutrinos, scintillation detector for, 18: 33901
interactions with protons at 24 Mev, proton energy spectra from disintegration, 18: 34771 (NP-14175)
interactions with deuterons at 25 Mev, differential cross section for elastic, 18: 34771 (NP-14175)
production by gamma absorption in oxygen-16, cross section for, 18: 34926
reactions (d,α) and (d,p) with oxygen-16 at 0.8 to 1.7 Mev, 18: 34860
reactions (d,α) with aluminum-27 at 1.5 to 2.6 Mev, 18: 34823
reactions (d,n) and (d,p) with deuterium at 25 Mev, differential cross sections for, 18: 34771 (NP-14175)
reactions (d,n) with deuterium, neutron polarization in, 18: 34963
reactions (d,n) with tritium in titanium, 18: 34375
reactions (d,n) with lithium-7, gamma emission in, 18: 34806
reactions (d,n) with deuterium and tritium, neutron yields from, 18: 34815
reactions (d,n) with neon-22 at 2.75 Mev, neutron emission in, 18: 34832
reactions (d,p), 18: 34861
reactions (d,p) and (d,t) with nuclei, diffraction mechanism for direct, 18: 34848
reactions (d,p) with lead-206, in unified model, 18: 34871
reactions (d,p) with calcium-48, 18: 34905
reactions (d,p) with boron-11 at 1 to 2.6 Mev, differential cross sections for, 18: 34909
reactions (d,p) with sulfur-32, cross sections, 18: 34752(R) (CU(PNPL)-234)
reactions (d,p) with nuclei at 7 to 12 Mev, distorted-wave approximation for, 18: 34774 (ORNL-P-144)
reactions (d,p) with cobalt-59, 18: 34827
reactions (d,p) with yttrium-89 at 12 Mev, 18: 34834
reactions (d,xγ) of, spin path mutual exchange in, 18: 34873
reactions in nuclear emulsion, radii for, 18: 34964
reactions of, polarization effects in stripping, 18: 34853
reactions with boron-11 and carbon-12 at 7 and 9 Mev, yields from, 18: 33932
reactions with deuterium mesic atoms, yields in, 18: 34617
reactions with heavy nuclei, neutron binding energies from, 18: 34966
scattering by carbon-12 at 5 to 60 Mev, crossover technique for energy determination in, 18: 34934
scattering by helium-4 at 2.9 to 11.5 Mev, 18: 34867
scattering by helium-4 at 25 Mev, differential cross section for, 18: 34771 (NP-14175)
scattering by nuclei at 7 to 12 Mev, distorted-wave approximation for inelastic, 18: 34774 (ORNL-P-144)
scattering by nuclei, diffraction mechanism for elastic, 18: 34848
scattering by oxygen-16 and vanadium-51 at 8.0 to 10.5 Mev, analyses of elastic, 18: 34758 (JEN-130-DF/I-41)
scattering by strontium and tin isotopes at 13.6 Mev, angular distributions for elastic, 18: 34942
scattering by tin isotopes at 13.6 Mev, excitation in inelastic, 18: 34941

DEXTRAN
effects of infusions of, on number of circulating leukocytes in rats, 18: 33215(R) (TID-20824)

DIAPHRAGMS
design for glass blowing on contaminated apparatus, 18: 33718
joining of metal, into cells, 18: 34032(R) (BMI-1668(Del.))

DIELECTRICS
electric conductivity, 18: 34694
electromagnetic wave diffraction by, perturbation formalism for, 18: 34346
radiation effects on, handbook on, 18: 34245

DIET
effects on calcium–strontium discrimination by rats, 18: 33805(R) (NIRS-2(p.57-67))

DIETHYLAMINE
complexes with europium benzoylacetonate, ligand field spectra of, 18: 33565

DIFFERENTIAL EQUATIONS
boundary-value solutions to ordinary second-order nonlinear, in field theory and nuclear theory, 18: 34269 (JINR-P-1682)
correlation functions from linear, for subcritical reactivity measurements, 18: 35078 (TID-7679(p.321-9))
determination of diffusivity of isotropic medium, 18: 34018
solution for flux and concentrations of mixture in separation stage, 18: 34004 (CEA-R-2337)

DIFFUSION
determination using mass spectrometers, 18: 33867
endpoint method generalization for, 18: 35056

DIMETHYLAMINE
effects on chemical equilibrium and rate of solvation of charge groups in aromatic compounds, 18: 33613

DIODES

performance of semiconductor lithium-drifted, as gamma pair spectrometers, 18: 33912
performance of superconducting tunnel, in microwave mixers, 18: 33824(R) (AD-428788)
performance of tunnel, in anti-walk discriminator, 18: 34752(R) (CU(PNPL)-234)
plasma production in, by electron beams, 18: 35044
radiation damage in silicon avalanche, single collision neutron, 18: 34248
use of tunnel, in recycling pulse generators, 18: 33857
use of tunnel, in time-to-pulse-height systems, 18: 33931
DIRECT ENERGY CONVERSION DEVICES
development of radioisotope-fueled, 18: 34002
energy conversion characteristics of brushless d-c servomotor, 18: 34498 (UCRL-11334)
DISASTERS
accident during plutonium purification on ion-exchange resins, study, 18: 33809(T) (HW-tr-78)
handling of, involving radioactive contamination, 18: 33817
DISEASES
classification of, chromosomal *vs.* global, 18: 33217
of kidneys, radiodiagnosis by scintillation scans, 18: 33433
radioinduced kidney, x, 18: 33288
DITHIZONE
solvent properties for copper, mercury, and silver, 18: 33509
DIVISION OF TECHNICAL INFORMATION EXTENSION, AEC
report number series used in cataloging of reports, 18: 35251 (TID-85 (3rd Rev.))
DOGS
iodine-131 uptake by blood plasma, liver, muscles, renal organs, and skin of, 18: 33251
pathological effects of injected strontium-90 in, 18: 33342
polonium removal from, effects of lagochylus on, 18: 33412
radiation effects on bone metabolism in, tracer study, 18: 33232(R) (NYO-910-3)
radiation effects on, proton, 18: 33286(T) (UCRL-Trans-1068)
radiation effects on conditioned reflexes in normal and bromide-treated, 18: 33319
radiation effects on transformation of cells of injected bone marrow in, 18: 33337
retention of inhaled plutonium-239 by, 18: 33260
DOLOMITES
origin of, oxygen isotope studies on, 18: 33786
DOUNREAY FAST REACTOR
cooling system treatment for corrosion inhibition, 18: 35063 (IG-Report-52)
noise measurements for, 18: 35158 (TID-7679(p.469-500))
DRESDEN POWER REACTOR
fuel cycle costs for, 18: 35151 (ORNL-TM-564)
water chemistry studies for, 18: 35185
DROSOPHILA
mutagenic effects of 4-nitro-1-oxide in, 18: 33273(R) (NIRS-2(p.42-8))
radiation effects on genetics of, cosmic, 18: 33354
radiation effects of X chromosome during spermatogenesis in, gamma, 18: 33378
radioinduced mutations in, effects of arginine on, 18: 33371
spermatozoa storage, mutagenic effects of, 18: 33273(R) (NIRS-2(p.42-8))
DRUGS
analysis for ash in vegetable, method for radiometric, 18: 33480
effects of lagochylus on polonium excretion in mice, rats, and dogs, 18: 33412
DRY BATTERIES
radiation effects on unsaturated acid Weston cadmium cells, 18: 34217 (NP-14183)
DRY BOXES
permeability testing of butyl rubber, neoprene, and polyvinyl chloride gloves for, 18: 34058(R) (WANL-PR(P)-003)
DUCTILITY
of thick steels, measurement by global and Robertson bend tests, 18: 34089(T,R) (EURAEC-915)
DYSPROSIUM
determination in biological materials, activation, 18: 33464 (NASA-CR-52997)
electric conductivity at room temperature to melting point of, 18: 34162
electric conductivity at 77 to 200°K, effects of pressure on, 18: 33592
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
structure at high pressure, x-ray-diffraction studies on, 18: 33591
DYSPROSIUM ISOTOPES
separation in calutrons, 18: 34007(R) (ORNL-TM-890)
DYSPROSIUM ISOTOPES Dy-160
energy levels, 18: 34844
energy levels of, measurement of lifetime of first excited, 18: 34772 (NP-14184)
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950
spin of, Coriolis anti-pairing and blocking effects on, 18: 34775 (TID-20875)
DYSPROSIUM ISOTOPES Dy-162
energy levels of, vibration-rotation interactions in, 18: 34846
DYSPROSIUM ISOTOPES Dy-164
spin of, Coriolis anti-pairing and blocking effects on, 18: 34775 (TID-20875)
DYSPROSIUM OXIDES
Dy_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Dy_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199

E

EARTH
lead evolution in, 18: 33792
surface heat flow of, radioactivity dependence of, 18: 33774
EARTHQUAKES
seismic signals from explosions and, auditory discrimination of, 18: 33765 (AD-437784)
ECOLOGY
book: *Radioecology of Marine Organisms*, 18: 33230
EGGS
iodine-131 uptake by, from hens, 18: 33255
radiation effects on encysted dry Artemia, fractionated-dose, 18: 33272(R) (NIRS-2(p.31-42))
ELASTOMERS
radiation and environmental effects in space, 18: 34235
ELECTRIC CONDENSERS
radiation and environmental effects in space, 18: 34235
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
radiation effects on, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation effects on, handbook on, 18: 34245
use of plasma, for electron diagnostics, 18: 34969 (AFCRL-64-247)
ELECTRIC CONDUCTIVITY
of quantum plasma in uniform magnetic field, 18: 34985
theory of plasma, equations for, 18: 35036
ELECTRIC CURRENTS
shortcircuiting in shock tubes, snowplow model for, 18: 34330
ELECTRIC DISCHARGE
cyclotron emission from Penning, 18: 34362
electrode design for, coaxial, 18: 33862
electron densities and temperatures in, Langmuir probe techniques for, 18: 34999
electron temperature relaxation in, method for measuring, 18: 34299
in helium, ion conversion rate and mobility in afterglow of, 18: 34351
production in gases by intense light pulses, 18: 34350
properties of semitoroidal reflex, for plasma propulsion, 18: 34290
radiation spatial distribution in afterglow of, 18: 34310
ELECTRIC FIELDS
Brownian-particle transport in, 18: 34349
charged-particle motion in neutral gases in, transients in, 18: 34364
effects of uniformity on receiving characteristics of two-wire lines, 18: 35249 (SC-R-64-164)
effects on gamma radiolysis of deuterated propane, 18: 33642
interaction with charged gas flow, electric power generation by, 18: 34501
interactions with inhomogeneous plasma, nonlinear effects in, 18: 35024
ELECTRIC GENERATORS
energy conversion characteristics of brushless d-c servomotor, 18: 34498 (UCRL-11334)
performance of electrogasdynamic, 18: 34501
ELECTRIC INSULATORS
development and testing for space power systems, 18: 34046(R) (NASA-CR-54041)
development for nuclear space propulsion systems, 18: 35216
development for pulsed-coil magnets, 18: 33717
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
radiation effects on, at low temperatures, 18: 34247
ELECTRIC POWER
development of nuclear, review of, 18: 35178
production by direct conversion of nuclear energy, properties and uses of nuclear batteries for, 18: 34500
production by electrogasdynamic generators, 18: 34501

production in fast breeder reactors, MHD impact flow tube for, 18: 35166(T) (ANL-Trans-38)
systems for space vehicles, 18: 33702
systems for space vehicles, 18: 33719
systems for space, 18: 33720
systems for SYNCOM satellites, 18: 33700

ELECTRIC PROBES
design of electron-density, 18: 34969 (AFCRL-64-247)
development for electron temperatures in unstable plasma, 18: 35021
performance of Langmuir, for afterglow electron density and temperature measurements, 18: 34999
plasma sheath around Langmuir, relation for, 18: 35043

ELECTRODES
design for sputter-ion gettering device, 18: 33875(P)
design of coaxial, 18: 33862
fabrication and performance of metal matrix-refractory additive, for thermionic devices, 18: 34505(P)

ELECTROLYTES
radiation effects on rat blood distribution of, gamma, 18: 33272(R) (NIRS-2(p.31-42))

ELECTROMAGNETIC FIELDS
charged particle motion in, hydrodynamical model, 18: 34638
charged-particle delay lines from, 18: 34277 (NP-14134)
fluid flow in, survey on, 18: 34264 (ARL-63-175(Pt.II))
interactions with vector mesons, 18: 34545
propagation in moving conducting medium, 18: 34320
shock wave interactions with, magnetic field diffusion in, 18: 34333
statistical mechanics, 18: 34971 (ARL-64-85)

ELECTROMAGNETIC PUMPS
design of reversible, 18: 33727(P)

ELECTROMAGNETIC WAVES
conversion to chemical energy for biological systems, 18: 33218
damping in plasma, 18: 35016
diffraction by dielectrics, perturbation formalism for, 18: 34346
interactions in plasma, nonlinear excitation of hydromagnetic waves and hybrid resonances in, 18: 34967 (AFCRL-63-786)
interactions of longitudinal and transverse, in plasma, 18: 35025
interactions with plasma, model for nonlinear, 18: 34970 (AFCRL-64-250)
interactions with hydromagnetic waves at plasma-gas interface, 18: 35004
propagation in ionosphere, 18: 34679
propagation in materials at low temperature, 18: 34694
propagation in metallic plasma along magnetic field, 18: 35045
propagation in moving conducting medium, 18: 34320
propagation in plasma in magnetic field, collision effects in, 18: 35038
reactions and scattering of, theory of, 18: 34624

ELECTROMAGNETISM
theory for, S-matrix, 18: 34658

ELECTRON BEAMS
effects on bone metabolism in dogs, tracer study of, 18: 33232(R) (NYO-910-3)
injection and containment in magnetic mirrors by cyclotron resonance instability, 18: 35008
interactions in plasma, instabilities from, 18: 35011
ionization of gas by, in diodes, 18: 35044
ionization of lithium ions by, research program on, 18: 34406(R) (TID-20877)
phase-space occupation of, 18: 34641
stability of, in d-c-pumped wave amplifiers, 18: 34379

ELECTRON MICROSCOPY
stripping carbon replicas for, chemical, 18: 33549

ELECTRON PAIRS
production in photon reactions with hydrogen atoms, recoil distribution in, 18: 34439

ELECTRON TUBES
failure of klystron windows in Stanford linear accelerator environment, 18: 33841(R) (TID-20833)
failure of klystron windows in Stanford linear accelerator environment, 18: 33842(R) (TID-20834)
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
use in amplifiers for semiconductor detectors, 18: 33928

ELECTRONIC EQUIPMENT
design and development of, summary, 18: 34752(R) (CU(PNPL)-234)
design and development for space vehicle electric power systems, 18: 35197(R) (64SD700)
development and testing of switchgear for space uses, 18: 33828(R) (NASA-CR-54059)
development and testing for space power systems, 18: 34046(R) (NASA-CR-54041)
development of Mw d-c-to-d-c converters for space uses, 18: 34497(R) (NP-12888(Vol.5))
development of, for conversion of radiation count rate to color change, 18: 33968
performance of radiation-resistant, 18: 33869

ELECTRONS
attenuation by aluminum, 18: 33886(T) (JPRS-25467(p.9-24))
chemical effects on terphenyls, 18: 33619 (MITNE-48)
density and energy of gas of, 18: 34644
density and temperature of plasma, measurement of, 18: 34999
density behind shock front in hydrogen plasma, 18: 34983
density distribution in ionosphere, 18: 34678
density fluctuations of atmospheric, satellite radio effects, 18: 34253
density in auroral regions, 18: 34672
density in plasma, interferometer for detecting changes in, 18: 35022
density measurements for plasma, impedance condenser probe for, 18: 34969 (AFCRL-64-247)
detection and measurement of, scintillation time-of-flight system for, 18: 33972
detection and measurement of, secondary-emission monitors for, 18: 34258(R) (AD-417250)
detection by silicon junction detectors, transient response for, 18: 33919
detection using phosphors at 0.6 to 1 Mev, response for, 18: 33902
distribution function in slightly ionized gases, 18: 34457
distributions of proton-impact-produced, in gases, 18: 34404(R) (COO-1277-5)
drift velocity in moderator–noble gas mixtures in electric fields, 18: 34322
drift velocity in argon, gas chromatography detector for, 18: 33476
effects of nonthermal, in auroral absorption of radio waves, 18: 34254
effects on electric conductivity of gold, annealing of, 18: 34249
effects on electrodes in nickel–cadmium batteries, 18: 34213(R) (AI-64-11)
effects on fused chloride and fluoride salts, 18: 34050(R) (ORNL-3626 (p.59-164))
effects on gallium arsenides, 18: 34352
effects on radiation-resistant electronic equipment, 18: 33869
emission from alpha reactions with thin foils, secondary, 18: 33911
emission from cesium plasma capillary emitter with high current density, 18: 34502
emission from photomultiplier dynodes, effects of time-dependent, 18: 33910
emission of secondary, from bombardment of beryllium-copper alloys and sodium chloride, 18: 34450
emission of secondary, from x-ray scattering by lead, 18: 34274(R) (NIRS-2(p.3-15))
energy of atomic systems of, 18: 34353
injection and accumulation in storage rings, 18: 34370 (LAL-1110)
interaction of laser beam with atomic, 18: 34458
interactions with phonons, theory for, 18: 34453
interactions with long-wavelength phonons, 18: 34454
interactions with deuterons, wave function dependence of cross section for inelastic, 18: 34555
interactions with mesons (π), radiative corrections to, 18: 34563
interactions with positrons in nuclear Coulomb field, single-quantum annihilation in, 18: 34577
interactions with antineutrinos and neutrinos, spin correlations in, 18: 34614
interactions with surfaces in vacuum gages, effects of, 18: 33759 (AD-427830)
interactions with phonons in superconductors, 18: 34708
interactions with phonons in superconductivity, 18: 34722
interactions with x rays in crystals, recoil resonance in, 18: 35242 (CALT-221-2)
ionization of gases by relativistic, effects of pressure and temperature on, 18: 34270 (LAL-1093)
isospinor field for, 18: 34527
kinetics in gases of, particle-hole exchange scattering in, 18: 34342
motion in neutral gases, transient space-charge, 18: 34364
orbitals of, geminal product approximation of, 18: 33554
oscillations in gases, 18: 35002
oscillations in magnetoplasma, instabilities of Langmuir, 18: 34989
photoproduction of, energy for, 18: 33860
photoproduction on atoms, relativistic, 18: 34847
polarizability of, 18: 34526
precipitation into atmosphere during auroral storms, observations of, 18: 34671 (AFOSR-425)
production of electron–positron pairs by fast electrons, 18: 34258(R) (AD-417250)
reactions (e,n) with nuclei at 16 Mev, neutron spectra of, 18: 34945

reactions with aluminum and tantalum at 10 and 20 Mev, bremsstrahlung from, 18: 34459
reactions with antimony–indium alloys, damage effects in, 18: 34240
reactions with ethane and ethylene molecules at 70 ev, mass spectra of fragments from, 18: 34433
reactions with lead, tin, tungsten, and zirconium, ionization in, 18: 34431
reactions with light nuclei at 1 and 4 Bev, proton production in, 18: 34916
reactions with molecules at 1.7 to 3.5 ev, vibrational excitation in, 18: 34440
reactions with oxygen-doped silicon, infrared absorption bands in, 18: 34239
reactions with silicon junction detectors at 0.05 to 1.0 Mev, internal pulse amplification in, 18: 33959
recombination with molecular positive ions, 18: 34259 (AD-434907)
resonance in plasma, nonlinear theory of cyclotron, 18: 34988
scattering by aluminum at 150 Mev, electron–positron pairs from, 18: 34258(R) (AD-417250)
scattering by helium-3 and hydrogen-3, 18: 34912
scattering by helium–hydrogen mixtures, Cherenkov radiation and ionization from, 18: 34258(R) (AD-417250)
scattering by hydrogen atoms, exchange, 18: 34446
scattering by hydrogen, radiative corrections to Cherenkov, 18: 34258(R) (AD-417250)
scattering by lithium, excitation cross sections for, 18: 34429
scattering by molecules, effects of compound negative-ion states in, 18: 34303
scattering by neon, excitation cross sections for, 18: 34430
scattering by nitrogen, mechanism of excitation and de-excitation of molecular vibrations in, 18: 34304
scattering by nitrogen-14 at 121 and 180 Mev, inelastic, 18: 34825
scattering by nuclei, analysis of, 18: 34928
scattering by screened Coulomb potential, phase shifts for, 18: 34528
scattering of relativistic, energy loss mechanisms in, 18: 34258(R) (AD-417250)
scattering of, theory of, 18: 34624
temperature relaxation time in electric discharge, 18: 34299
temperatures in unstable plasma, double-probe method for, 18: 35021
transit times in photomultipliers, uses for, 18: 33961
use in heating liquid metals, 18: 33731 (ANL-6869)
wave function of single bound, use in molecular Schroedinger equation, 18: 34422
wave functions for, calculation of hydrogen-like and single exponential, 18: 34428
wave functions of one- and two-, calculation of, 18: 34425
wave functions of systems of two-, Gaussian correlation functions for, 18: 34427

ELECTROPHORESIS
radiation effects on electrophoretic distribution of proteins in blood serum, 18: 33353

ELECTROSTATIC FIELDS
altitude variation of atmospheric, over contaminated ground, 18: 33773

ELECTROSTATIC GENERATORS
properties of oblique-field and single-capacitor, 18: 33720

ELECTROSTATIC SEPARATION
use in Rankine-cycle power plants, 18: 33701

ELEMENTARY PARTICLES
bound-state equivalence with, having zero wave function renormalization constants, 18: 34522
classification of, SU(6) representation for, 18: 34582
coupling constant and mass formulas for, in broken symmetry schemes, 18: 34589
interactions at high energies, strange-particle production in, 18: 34509 (NP-14086)
interactions of zero-spin, with photons, 18: 34538
interactions of, broken SU(6) symmetry in strong, 18: 34583
interactions of, local operators and s-matrix for, 18: 34541
interactions of, model of resonance, 18: 34564
interactions of, relation of mutual and self, 18: 34540
interactions of, SU_3 model for strong, 18: 34510 (NP-14146)
interactions of, singlet amplitude in intermediate vector boson theory of, 18: 34531
interactions of, with four-body correlation, 18: 34600
interactions under T-L invariance and $\Delta T = \frac{1}{2}$, SU(3) transformation properties of weak, 18: 34570
mass spectra of baryons, leptons, and mesons, 18: 34603
model for, axial-vector-current, 18: 34565
model for, based on parity doublet hypothesis, 18: 34612
model of, in broken U_3 symmetry scheme, 18: 34613
motion in gravitational field, geodesic postulate for, 18: 34335
possibility of fractionally charged, in SU_3 model for strong interaction symmetry, 18: 34510 (NP-14146)
production of, angular correlations in, 18: 34569
properties of, review of, 18: 34599
quantum numbers of, 18: 34625
reactions with nuclei, book on, 18: 34956
research progress on, 18: 34271(R) (LAL-1107)
scattering amplitudes of, N/D formalism for, 18: 34605
symmetries of, four-dimensional interpretation of, 18: 34588
symmetry representation for, using SU_3 subgroups, 18: 34529
theorem for strangeness-violating vector currents, nonrenormalization, 18: 34596
theory for spin ½ and ⅜, equivalence of covariant, 18: 34547
theory of, tests of conserved-vector-current, 18: 34561

ELEMENTS
contents in K-giant stars, 18: 34385
energy levels for $z = 5$ to 24, atomic, 18: 34414
synthesis in solar system, 18: 34274(R) (NIRS-2(p.3-15))

ELK RIVER POWER REACTOR
pressure vessel testing for, 18: 35154(R) (SWRI-1228-28)

EMBRYOS
development of Artemia, 18: 33271(R) (NIRS-2(p.26-31))
effects of cerium-144 on growth and development of, in pregnant rats, 18: 33352
radiation effects on cells of chick, gamma, 18: 33271(R) (NIRS-2(p.26-31))
radiation effects on toad, protective effects of dinitrophenol against x, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on post-natal physiological processes and adult pathology of mice and rats, 18: 33280(R) (TID-20831)
radiation effects on death of, in rats, 18: 33280(R) (TID-20831)
radiation protection of, in rats and mice, 18: 33423

ENTROPY
quantization of, 18: 34694

ENZYMES
activity of enolase, in leukemic and normal leukocytes, 18: 33231(R) (NIRS-2(p.49-56))
preparation of RNA polymerase from *M. lysodeikticus*, 18: 33243
properties of RNA polymerase from *M. lysodeikticus*, 18: 33244
properties of RNA polymerase, from *M. lysodeikticus*, 18: 33245
radiation effects on activity of, in stored blood, 18: 33345
radiosensitivity of, controlling heme synthesis, 18: 33400

EPITHELIUM
radiation effects on histopathology of fish intestinal, x, 18: 33272(R) (NIRS-2(p.31-42))

EQUATION OF STATE
for gas with weak long-range positive potential, 18: 34655
fugacity coefficients from, derivation of, 18: 33531 (UCRL-11369)
of ideal nonrelativistic Fermi-Dirac gas, 18: 34645

EQUIPMENT AND PROCEDURES
development for Fission Products Development Laboratory, 18: 34007(R) (ORNL-TM-890)

ERBIUM
electric conductivity at room temperature to melting point of, 18: 34162
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192

ERBIUM IONS
spectra in lanthanum fluoride, coherent emission and energy levels in absorption, 18: 33562
spectrum in yttrium oxide single crystals, absorption and fluorescence, 18: 34305

ERBIUM ISOTOPES Er-164
energy levels of, measurement of lifetime of first excited, 18: 34772 (NP-14184)

ERBIUM ISOTOPES Er-166
energy levels of, measurement of lifetime of first excited, 18: 34772 (NP-14184)
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950
spin of, Coriolis anti-pairing and blocking effects on, 18: 34775 (TID-20875)

ERBIUM ISOTOPES Er-168
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950
spin of, Coriolis anti-pairing and blocking effects on, 18: 34775 (TID-20875)

ERBIUM ISOTOPES Er-170
neutron capture cross sections, 18: 33678(R) (ANL-6875)

ERBIUM TELLURIDES
electric properties and uses of, 18: 34158

ERYTHROCYTES
hemoglobin and DNA synthesis in, and precursors in rats, 18: 33234 (UCRL-11459)
life span and iron metabolism in, tracer studies, 18: 33214 (STI/DOC/10-28(p.105-11))
morphology of, effects of free amines in blood on, 18: 33277 (STI/DOC/10/28(p.21-38))
ozone effects on, 18: 33334
radiation effects on, x, 18: 33334
radiation effects on guinea pig, 18: 33363
radioinduced hemolysis of, in stored blood, 18: 33345
ERYTHROPOIETIN
action mechanism of, 18: 33231(R) (NIRS-2(p.49-56))
effects on heme synthesis by bone marrow cells, 18: 33242
physiological effects of, in irradiated animals, 18: 33277 (STI/DOC/10/28(p.21-38))
ESCHERICHIA COLI
mutations of, 18: 33212(R) (NYO-2570-1)
radiation effects on thymine dimer excision from DNA of, uv, 18: 33298
radiation effects on genetics of, cosmic, 18: 33354
radiation injuries in, protective effects of sulfhydryl compounds against, 18: 33275(R) (NYO-910-2)
radiosensitivity of vegetative, effects of freezing on gamma, 18: 33326
ESTROGENS
excretion in irradiated cervical carcinoma, 18: 33287
ETHANE
ionization by ions at 200 to 1200 kev, mass-to-charge ratios from, 18: 34433
radiolysis of hydrogen in deuterated, proton transfer reactions of H_3^+ in, 18: 33639
vapor pressure of deuterated, 18: 33557
ETHANE, DIBROMOCHLOROTRIFLUORO-
fluorine-19 NMR in, spin-spin coupling constants for, 18: 33532 (UCRL-11395)
ETHANE, DICHLOROFLUORO-
fluorine-19 NMR in, spin-spin coupling constants for, 18: 33532 (UCRL-11395)
ETHANE, IODO-
ionization of, appearance potential measurements on secondary ions produced by, 18: 33569
ETHANETHIOL, 2-AMINO-
protective effects against giant cell formation in HeLa animal cells, 18: 33405
ETHANOL
effects on radioinduced polymerization modification of acrylonitrile, 18: 33650
ETHANOL, 2-AMINO-
analysis for active hydrogen by NMR spectroscopy, 18: 33475
ETHER, BENZYL METHYL
dissociation of, appearance potentials and energies in electron, 18: 33627
ETHYL ACETATE
ethyl acetate–TBP, solvent properties for uranium from aqueous solutions, 18: 33680 (JEN-137-DQ/I-41)
ETHYLENE
ionization by ions at 200 to 1200 kev, mass-to-charge ratios from, 18: 34433
radioinduced polymerization of, induction period, rate, and weight of polymer in, 18: 33649
ETHYLENE, BROMOTRIFLUORO-
fluorine-19 NMR in, spin-spin coupling constants for, 18: 33532 (UCRL-11395)
ETHYLENE, CHLORO- POLYMERS
permeability to oxygen and water vapor, 18: 34058(R) (WANL-PR(P)-003)
sorptive properties of Tygon for young fission products from solutions, 18: 33448 (IDO-14644)
ETHYLENE, DIBROMO-
neutron scattering in, at 4 to 11 Å, 18: 34752(R) (CU(PNPL)-234)
ETHYLENE GLYCOL POLYMER ETHERS
binder effects on grain growth and solarization of sintered uranium dioxide pellets, 18: 34170
ETHYLENE POLYMERS
radiation effects on infrared and x spectra of, gamma, 18: 34220 (TID-20787)
sorptive properties for young fission products from solutions, 18: 33448 (IDO-14644)
spectra, effects of melting on infrared, 18: 34220 (TID-20787)
ETHYLENIMINE
aberrant effects on chromosomes, mechanism of, 18: 33271(R) (NIRS-2(p.26-31))
mutagenic effects in *Vicia faba*, 18: 33303
mutagenic effects on barley seeds, 18: 33375
EUROPEAN ATOMIC ENERGY COMMUNITY
decontamination equipment used by, 18: 33800 (EUR-1821.f)
EUROPIUM
melting curve at high pressures, 18: 34184
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
separation from ammonium nitrate solutions by solvent extraction using trioctylphosphine oxide, 18: 33686
EUROPIUM COMPLEXES
fluorescence decay time and quantum yield of, quenching and temperature dependence in, 18: 33556
with benzoylacetonate and diethylamine, morpholine, or piperidine, ligand field spectra of, 18: 33565
with 1-phenyl-1,3-butanedione, laser properties of, 18: 33561
EUROPIUM IONS
distribution between phases in boron oxide–sodium chloride–sodium oxide system at 830°C, 18: 33534 (USNRDL-TR-760)
EUROPIUM ISOTOPES Eu-152
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
decay of, monoenergetic positron emission in, 18: 34820
EUROPIUM ISOTOPES Eu-154
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
EUROPIUM SELENIDES
specific heat at 1.3 to 20°K, 18: 34695
EUROPIUM TELLURIDES
specific heat at 1.3 to 20°K, 18: 34695
EXCRETION
of radioisotopes, determining tissue dose by, 18: 33428
radiation effects on estrogen and steroid, 18: 33287
EXHAUST SYSTEMS
design for internal combustion engines using depleted uranium for catalytic oxidation, 18: 33610(P)
EXPERIMENTAL BREEDER REACTOR-II
development and operation, May 1964, 18: 35060(R) (ANL-6904)
fuel element meltdown failure in, coherence of hypothetical, 18: 35059 (ANL-6844)
fuel element processing by pyrometallurgical methods for, 18: 33678(R) (ANL-6875)
fuel processing for, development of pyrometallurgical processes for, 18: 33683 (TID-8540(p.411-76))
EXPERIMENTAL GAS COOLED REACTOR
cooling system of, analysis of blower and temperature controller in, 18: 35164 (TID-20891)
safety system design analysis, 18: 35163 (TID-20890)
EXPLOSIONS
of 20-ton TNT charge on ground, general measurements of, 18: 34278 (NP-14174(Vol.1))
seismic signals from earthquakes and, auditory discrimination of, 18: 33765 (AD-437784)
shock effects on magnetic susceptibility of magnetite grout mixtures, 18: 34284 (UCRL-13088)
EXPLOSIVES
impact sensitivity, survey of mechanisms of, 18: 35252 (UCRL-7898)
EXPONENTIAL PILES
neutron flux distributions in, time-dependent thermal, 18: 35225
noise analyses of Japanese, 18: 35073 (TID-7679(p.155-69))
physics measurements for water-moderated slightly enriched, 18: 35113 (TID-8540(p.529-609))
reactivity measurements for, noise techniques in, 18: 35072 (TID-7679 (p.135-54))
reactivity measurements using source excitation and correlation techniques for, 18: 35076 (TID-7679(p.219-28))
reactivity of, C(R) analysis of, 18: 34495 (GA-5404)
reactivity of, correlation-function analysis of, 18: 35078 (TID-7679 (p.321-9))
EXTENSOMETERS
description for use at high temperatures, 18: 34128 (RTD-TDR-63-4068)
EXTRACTION APPARATUS
design and development of centrifugal, for air-water and steam-water systems, 18: 33693(R) (ACNP-64026)
EYES
hydrogen peroxide effects on retinal development, 18: 33343
radiation effects on retinal development, x, 18: 33343

F

FALLOUT
analysis of high-activity, in French Territory, 18: 33770 (SCPRI(S)-99)
cesium-137 body burden from, 18: 33805(R) (NIRS-2(p.57-67))
cesium-137 in, uptake by muscles of, 18: 33427

content in milk and people in France, 1961–1964, 18: 33429
content in soil at Warsaw, 18: 33778
distribution from cratering shots in basalt, 18: 33775
distribution in marine organisms, 18: 33230
effects on atmospheric electrostatic field, 18: 33773
marine contamination by, 18: 33779
monitoring atmospheric, Hungary, 1961 and 1962, 18: 33771
monitoring in Germany, 1962, 18: 33772
monitoring in Japan, 1963, 18: 33263
monitoring 1963, in United States, 18: 33818
strontium-90 content in Western Slovakia, 18: 33776
uptake by Japanese vegetables, 18: 33805(R) (NIRS-2(p.57-67))

FAST REACTORS
core design for liquid-metal-cooled, 18: 35105(P)
design for large multiregion, 18: 35125(P)
design of settled-bed, 18: 35124(P)
excursions in liquid-metal-cooled ceramic, 18: 35146(R) (GEAP-4601)
fuel cycles in ceramic, effects of plutonium recycling schemes on, 18: 35146(R) (GEAP-4601)
fuel development and reprocessing for, 18: 35060(R) (ANL-6904)
fuel development for, 18: 33678(R) (ANL-6875)
fuel element meltdown failure in EBR-II-like, coherence of hypothetical, 18: 35059 (ANL-6844)
fuels for power, development and testing of ceramic, 18: 35146(R) (GEAP-4601)
kinetics of liquid-metal-cooled ceramic, 18: 35146(R) (GEAP-4601)
neutron dosimetry in, 18: 34263 (ANL-6826)
power production in liquid-metal-cooled breeder, MHD impact flow tube for, 18: 35166(T) (ANL-Trans-38)
review and survey of power, 18: 35161 (TID-8540(p.71-129))

FATTY ACID ESTERS
radioinduced free radicals in urea inclusion compounds with, ESR spectra and molecular motion of, 18: 33641

FECES
analysis for gamma-emitting radioisotopes, spectrometric, 18: 33264
analysis of, for estimation of lung burdens of inhaled radioactive particles, 18: 33266

FEEDBACK SYSTEMS
statistical characteristics of loop in radiometric control systems, 18: 33844(T) (AEC-tr-6399(p.10-20))

FERMI FAST BREEDER REACTOR
startup, 18: 35139 (APDA-NTS-1)

FERMIONS
density matrix for, approximate second-order, 18: 34525
integrals for gases of, 18: 34654
interactions in many-body systems of, perturbation series for ground-state, 18: 34559
partition function for hard-sphere, formula for, 18: 34664
quasiparticle lifetimes in many-body system of, 18: 34549
spin, 18: 34625
superfluidity in systems of, 18: 34864

FERMIUM ISOTOPES Fm-254
nucleon vibrational-rotational interactions in, 18: 34950

FERROIN
complexes with cyanide, electron transfer in cerium oxidation of, 18: 33550
oxidation by cerium and cobalt in acid media, electron-transfer reactions in, 18: 33550

FERROMAGNETIC MATERIALS
Ising model for, algebraic solution of, 18: 34356

FERTILIZERS
effectiveness of foliar application of, tracer studies on, 18: 33213 (STI/DOC/10/28(p.79-103))

FETUSES
radiation effects on developing, in hamsters, 18: 33322
radiosensitivity of liver in, of mice, 18: 33344

FFAG ACCELERATORS
vacuum chamber resonator for 100-Mev, 18: 34371 (NP-13986)

FIELD EMISSION MICROSCOPY
book: *Advances in Catalysis and Related Subjects*, 18: 33453
developments in ultrahigh, for surface kinetic studies, 18: 33454

FIELD LABORATORIES
design of mobile whole-body counter, 18: 33802 (HW-80216)

FIELD THEORY
bootstrap calculations for vector mesons in, 18: 34557
bootstrap hypothesis in SU(3) for baryon-meson resonances, reciprocal, 18: 34556
boundary-value problems in, solutions to ordinary second-order nonlinear differential equations for, 18: 34269 (JINR-P-1682)
elementary particle mutual and self interactions in, 18: 34540
elementary particle motion in, geodesic postulate for, 18: 34335
formalism for atomic total energy calculations, 18: 34437
formalism for Einstein-Schroedinger type of unified, 18: 34642
Green functions in quantum, 18: 34648
interactions of electromagnetic and vector meson fields, 18: 34545
Maxwell's equation in classical, derivation of, 18: 34669
photon interactions with zero-spin particles at low energies, 18: 34538
potentials in, baryon-charge and hyper-charge, 18: 34647
quantization of Schroedinger equation, canonical, 18: 34639
quaternion formalism for, 18: 34667
representation of canonical variables in quantum, 18: 34653
stability of solutions in symmetry breakdown theory, 18: 34666
SU_3 model for strong interaction symmetry and its breaking, 18: 34510 (NP-14146)
transformation matrix for isotropic harmonic oscillator eigenvectors, 18: 34807
unitary symmetry and nonleptonic decays, 18: 34578
weak currents for strongly interacting particles in, commutation relations for, 18: 34657

FILMS
electric current distribution in superconducting, carrying quantized fluxoids, 18: 34688
electrical properties of bridges of superconducting, v-f effects in, 18: 34710

FILTERS
efficiency of activated charcoal for iodine-131, 18: 33808(T) (AEC-tr-6459)

FISH
calcium and strontium uptake by gills of, comparison, 18: 33805(R) (NIRS-2(p.57-67))
fission product content of, from contaminated waters, 18: 33248
metabolism of cesium-137 by, 18: 35238 (STI/DOC/10/28(p.9-20))
metabolism of phosphorus-32 by, 18: 35238 (STI/DOC/10/28(p.9-20))
radiation effects on survival of, dose-dependence of, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on intestinal epithelium histopathology in, x, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on adrenal cortex histology in, x, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on pigment production in, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on, development of conditioned reflex to gamma, 18: 33366
radiation effects on, protective effects of reserpine against x, 18: 33272(R) (NIRS-2(p.31-42))
tantalum-182 uptake by, 18: 33805(R) (NIRS-2(p.57-67))

FISSION
distribution in seven-pin cluster elements, 18: 35131
model of, cluster, 18: 34872
theory of, liquid-drop, 18: 34778 (UCRL-11338)

FISSION CHAMBERS
neutron dosimetry using, 18: 33979(P)

FISSION-COUNTING ANALYSIS
pulse sampling for determination of transfer function, harmonic analysis of instantaneous counting rate from, 18: 35079 (TID-7679(p.331-4))

FISSION PRODUCTS
analysis for cerium-141 and -144, simultaneous, 18: 33465 (USNRDL-TR-756)
buildup of iodine and tellurium, in research reactors, 18: 35228
deposition studies in out-of-pile loop, 18: 34034(R) (BMI-1672(Del.))
detection and measurement in-pile, instrumentation technology review for, 18: 35089 (TID-8540(p.177-211))
detection of, semiconductor detectors for, 18: 33955
determination in urine and feces of, gamma spectrometric, 18: 33264
effects on sorption in mouse brain and kidneys, 18: 33358
metabolism by algae, 18: 35238 (STI/DOC/10/28(p.9-20))
precipitation from atmosphere over Hungary, 1961 and 1962, 18: 33771
processing of, shutdown maintenance of Fission Products Pilot Plant for, 18: 34006(R) (ORNL-TM-889)
properties and uses, 18: 33984 (TID-8540(p.477-528))
radiation dose from, beta and gamma contributions to, 18: 33633
release from irradiated coated fuel particles, 18: 34033(R) (BMI-1669 (Del.))
release from irradiated coated fuel particles, 18: 34034(R) (BMI-1672 (Del.))
release from irradiated uranium–zirconium hydride SNAP 10A/2 fuel, 18: 34045 (NAA-SR-9673)
release from uranium carbide in TREAT, 18: 35247(R) (NAA-SR-9700)
release of gaseous, from arc-cast uranium monocarbide, 18: 34032(R) (BMI-1668(Del.))
release of gaseous, from coated-particle fuels, 18: 34032(R) (BMI-1668 (Del.))

release of gaseous, from irradiated beryllia–uranium dioxide dispersion, 18: 34033(R) (BMI-1669(Del.))
release of gaseous, from irradiated beryllia–uranium dioxide at 1200 to 1600°C, 18: 34034(R) (BMI-1672(Del.))
release of gaseous, from sintered uranium dioxide pellets, postirradiation annealing studies, 18: 34214 (EURAEC-1126)
release of gaseous, from vented oxide fuel elements, 18: 35146(R) (GEAP-4601)
separation from Hanford wastes for use as heat sources, 18: 33983 (HW-SA-3080(Rev.))
sorption by surfaces in STEP programs, 18: 33448 (IDO-14644)

FISSION RECOILS
argon-methane ionization by curium-244 and uranium-235, 18: 33895
detection in silicon surface barriers, multiplication in pulse-height response to, 18: 33915
detection using silicon surface-barrier detectors, 18: 33945

FISSIUM
development for use as fast reactor fuel, 18: 35060(R) (ANL-6904)
preparation of fissia fuel elements, 18: 35146(R) (GEAP-4601)

FLOWMETERS
design of liquid, 18: 33871(P)

FLUID FLOW
analysis of rocket engine, computer program for, 18: 33751
convection in rectangular channels with unequally heated walls, 18: 33746
dynamics in von Kármán wake of rectangular cylinder, 18: 33748
free-molecule flow field over moving circular plate in, 18: 33742
heat transfer conducting incompressible, in magnetic field, 18: 34359
heat transfer in transition boiling, to rods, 18: 33734(R) (GEAP-4646)
heat transfer in von Kármán wake of rectangular cylinder, 18: 33748
interactions between strong Couette and weak pressure, 18: 33697(R) (SWRI-1228-26)
magnetohydrodynamic, survey on, 18: 34264 (ARL-63-175(Pt.II))
magnetohydrodynamic, stability of channel flow in aligned fields, 18: 34267 (D1-82-0331)
magnetohydrodynamic, past insulated flat plate, 18: 34316
magnetohydrodynamic, stagnation-point, 18: 34319
magnetohydrodynamic, magnetic energy production and dissipation in, 18: 34327
measurement using radioisotopes, total-sample method for, 18: 33750
of steam–water mixture, pressure drop in forced, 18: 33745
of water through heat exchangers, total-sample method for measuring rate of, 18: 33750
stability of Couette, in transverse magnetic fields, 18: 34317
swirl, boiling burnout with heated twisted tapes, 18: 33738 (ORNL-TM-894)
two-phase adiabatic, liquid volume fraction measurement in, 18: 33732 (EURAEC-1086)
two-phase, statistical analysis of steam-void fraction in, 18: 35073 (TID-7679(p.155-69))
void volume measurements in two-phase, by gamma attenuation and manometer techniques, 18: 33729(R) (ACNP-64027)

FLUID FUEL REACTORS
development of molten-salt, 18: 35064(R) (ORNL-3626)

FLUIDS
density correlations in, kinetic model for time-dependent, 18: 34347
detonation wave propagation in conducting, in magnetic fields, 18: 34329
hydromagnetic wave propagation by oscillating conducting boundary in, 18: 34328
quantum equilibrium properties and self-diffusion coefficients of dense, relation between, 18: 34307
radial distribution functions for, equations for calculating square-well potential and virial coefficients from, 18: 34300
thermodynamics of classical monatomic, radial distribution function for, 18: 34344

FLUORESCENCE
decay time of, device for measuring, 18: 33637
theory of optical resonance, anticrossing and crossing effects in, 18: 33656

FLUORIDE VOLATILITY PROCESSES
corrosion studies, 18: 34032(R) (BMI-1668(Del.))
corrosion studies, 18: 34033(R) (BMI-1669(Del.))
corrosion studies, 18: 34034(R) (BMI-1672(Del.))
plutonium retention on fluidized alumina bed during fluorination of uranium oxide–plutonium oxide mixture, 18: 35060(R) (ANL-6904)
uses in reprocessing reactor fuel elements, 18: 33678(R) (ANL-6875)

FLUORIDES
phase equilibria with hydrofluoric acid–water mixtures, 18: 34050(R) (ORNL-3626(p.59-164))
properties of mixed metallic, in molten salt reactors, 18: 34050(R) (ORNL-3626(p.59-164))
separation with zirconium from solutions containing hydrofluoric acid, uranium, and zirconium by precipitation, 18: 33690(P)

FLUORINE
content in rhyolitic lava, 18: 33788
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
nuclear magnetic resonance in nickel fluosilicate, 18: 34275 (NP-14114)
nuclear magnetic shielding in, theory of, 18: 33563

FLUORINE ISOTOPES F-18
energy level population in (α,d) reactions, 18: 34779 (UCRL-11341)
energy levels, 18: 34869
energy levels of, tensor force effects on, 18: 34838

FLUORINE ISOTOPES F-19
deuteron reactions (d,p) at 1.75 Mev, 18: 34861
helium reactions (He-3,pγ) at 4.7 and 5.2 Mev, angular correlations for, 18: 34849
magnetic shielding anisotropy in xenon fluorides, 18: 33558
nuclear magnetic moments in thallium fluoride, 18: 34936
nuclear magnetic resonance of, spin-spin coupling constants for, 18: 33532 (UCRL-11395)
proton reactions (p,3n) with, neon-17 yield from, 18: 34899
reactions (F-19,F-18) with rhodium at 10 Mev, differential cross sections for, 18: 34951

FLUXMETERS
development for high fields at low temperatures, 18: 33865

FOILS
neutron self-shielding factors of, with predominant scattering, 18: 34737

FOOD
polonium-210 content of, 18: 33819
radiosterilization of beef, effects on wholesomeness, 18: 33992

FORMAMIDE, N,N-DIMETHYL-
nitrogen-14 NQR in, relaxation of, 18: 33615

FRANCE
fallout monitoring, 1961–1964, 18: 33429
radiation protection of population, public health aspects, 18: 33816
uranium-235 separation at Pierrelatte, 18: 34010

FRANCIUM ISOTOPES Fr-212
range-energy curves of 6- to 12-Mev recoils of, in aluminum and aluminum oxide foils, 18: 34782 (UCRL-11563)

FREE RADICALS
electron spin resonance spectra of oriented, in single crystals, 18: 33630
properties of radioinduced, in amide polymers, 18: 33669
radioinduced formation in frozen aqueous amino acid solutions, electron spin resonance spectra of, 18: 33675
radioinduced in alkyl ester-urea inclusion compounds, ESR spectra and molecular motion of, 18: 33641
radioinduced in biological materials, research program on, 18: 33274(R) (NYO-910-1)

FROGS
iodine-131 uptake by blood plasma, liver, muscles, renal organs, and skin of, 18: 33251
radiation effects on embryos of, protective effects of dinitrophenol against x, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on expansion of melanophore pigment in hypophysectomized, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on electroretinograms of, x, 18: 33343

FRUITS
radiation effects on grey rot in strawberry, gamma, 18: 33998
radiosterilization of strawberries, gamma, 18: 33993

FUEL CELLS
development for space power systems, status of, 18: 34001
development of, review of, 18: 34499

FURANS
radioinduced polymerization with acrylonitrile, infrared spectra of products in, 18: 33670

FURNACES
description for testing bare and coated refractory alloys at high temperatures, 18: 34128 (RTD-TDR-63-4068)
description of high-pressure, for infusion of helium into uranium dioxide at high temperatures, 18: 34055 (UCRL-11043)

FUSED SALTS
level indicators for, design of ultrasonic, 18: 33830(R) (NYO-10556)
properties for use in pyrometallurgical processing of irradiated reactor fuels, 18: 33678(R) (ANL-6875)
solvent properties for intermetallic compounds, 18: 33678(R) (ANL-6875)
thermodynamic properties, 18: 35247(R) (NAA-SR-9700)

G

GADOLINIUM
Curie temperature of, pressure dependence of, 18: 34173
determination by titration with sodium tungstate solution using bromocre-

sol and methyl red mixed indicator, 18: 33510
determination using sodium phosphate and bromocresol purple, volumetric, 18: 33481
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
neutron total cross sections, 18: 33678(R) (ANL-6875)
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
separation from thorium and uranium by paper chromatography, 18: 33505
GADOLINIUM ALLOYS
Gd–Mn, structure of $GdMn_2$, 18: 34026 (AD-428771)
GADOLINIUM ARSENIDES
electric properties and uses of, 18: 34158
GADOLINIUM IONS
electron paramagnetic resonance in metals of high paramagnetic susceptibility, 18: 33587
interactions with 87-kev state of gadolinium-155, hfs, 18: 34898
GADOLINIUM ISOTOPES Gd-154
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950
GADOLINIUM ISOTOPES Gd-155
energy level at 87 kev, hfs interaction of, 18: 34898
energy level transition (182 + 180)—87 kev of, 18: 34898
GADOLINIUM ISOTOPES Gd-156
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950
GADOLINIUM ISOTOPES Gd-158
energy levels of, vibration-rotation interactions in, 18: 34846
neutron capture cross sections, 18: 33678(R) (ANL-6875)
nucleon vibrational-rotational interactions in, 18: 34950
GADOLINIUM OXIDES
Gd_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Gd_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
GADOLINIUM SELENIDES
electric properties and uses of, 18: 34158
GADOLINIUM TELLURIDES
electric properties and uses of, 18: 34158
GAGES
radiometric, statistical characteristics of feedback loop in, 18: 33844(T) (AEC-tr-6399(p.10-20))
GALAXIES
cosmic-ray composition and energy spectra in, 18: 34491
GALLIUM
activation by thermal neutrons, self-shielding effects in, 18: 33488
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
performance as dopant in lithium-drifted silicon junctions, ion-pairing in, 18: 33922
ranges of atoms of, in copper and zinc at low energies, 18: 34441
GALLIUM ALLOYS
Ga–V, properties for use as superconductive wires, 18: 34200
Ga–V, radiation effects of neutrons on superconductivity of, 18: 34683(R) (NP-14136)
GALLIUM ARSENIDES
analysis for oxygen, activation, 18: 33541
radioinduced atomic displacement in, energy of electron, 18: 34352
GALLIUM ISOTOPES Ga-72
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
GALLIUM OXIDES
Ga_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Ga_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
GALLIUM SELENIDES
reactions with cerium selenides, 18: 33552
GAMMA-ABSORPTION ANALYSIS
of lead in ores and concentrates, 18: 33468(T) (AEC-tr-6399(p.61-71))
GAMMA CAMERAS
design of scintillation, for radioisotope observation *in vivo*, 18: 34403
sensitivity of multichannel scintillation, 18: 33940
GAMMA DECAY
intensities in, method for measuring, 18: 34800
GAMMA RADIATION
aberrant effects on Drosophila X chromosomes during spermatogenesis, 18: 33378
absorption and emission of, recoilless, 18: 34298
absorption by nucleon pairs in heavy nuclei, total cross section for, 18: 34925
absorption by nucleon pairs in oxygen-16, cross section for, 18: 34926
attenuation by concretes, 18: 35092(T) (JPRS-25467(p.1-8))
attenuation in shielding materials at 0.1 to 10 Mev, coefficients for, 18: 35058
backscattering from iron slabs, 18: 35054
biological effects in mice, rats, and dogs, 18: 33286(T) (UCRL-Trans-1068)
biological effects of, recovery from, 18: 33377
chemical effects on ketone extraction of uranyl nitrate, 18: 33621 (UJV-977/64)
chemical effects on liquid cyclohexanone, yields in, 18: 33623
chemical effects on liquid cyclohexanone, 18: 33624
chemical effects on gaseous hydrogen chloride, 18: 33625
chemical effects on polymers, 18: 34220 (TID-20787)
chemical effects on liquid methanol, effects of oxygen on, 18: 33618 (CONF-322-14)
chemical effects on terphenyls, 18: 33619 (MITNE-48)
detection and discrimination from neutrons, 18: 34752(R) (CU(PNPL)-234)
detection and measurement of whole-body retention of, from tracer doses of radioisotopes, 18: 33232(R) (NYO-910-3)
detection and measurement of, evaluation of organometallic compounds in plastic scintillators for, 18: 33939
detection and measurement of, efficiency of scintillation detectors for, 18: 33941
detection and measurement of, from first excited state transitions, 18: 34772 (NP-14184)
detection of, Cutie Pie Chamber response for, 18: 33883 (ORNL-TM-897)
detection of, stabilized scintillation counter for, 18: 33934
detection using alkali halide crystals, scintillation efficiencies for, 18: 33636
detection using scintillation spectrometers, pulse-height spectra in, 18: 33925
dose distribution in air at 0.05 to 10 Mev, 18: 33810
dose distribution of, in tumors, computer analysis of data on, 18: 33434
dose distribution calculations of, from cobalt-60 rotational teletherapy source, 18: 33445
dose rates in concrete blockhouse from ground sources, analysis of, 18: 35055
dosimetry in reactors, review of methods for, 18: 33879 (HW-SA-3585)
dosimetry of gross fission product, 18: 33633
dosimetry of high-level, using absorption in silver metaphosphate glass, 18: 33891(T) (ORNL-tr-216)
dosimetry of secondary, from atomic explosions, Monte Carlo program for calculating, 18: 34285 (WL-TDR-64-46(Vol.I))
effect on bacterial spores, 18: 33996
effects of therapeutic doses of, on morphology of bone marrow cells, 18: 33399
effects on annealing in malleable cast iron, 18: 34229
effects on Artemia eggs, 18: 33271(R) (NIRS-2(p.26-31))
effects on bacterial spores, 18: 33292
effects on bacteria, factors affecting, 18: 33326
effects on carbon dioxide exchange by *Pinus rigida*, 18: 33315
effects on carrier lifetime in silicon crystals, 18: 34228
effects on chick embryo cells, 18: 33271(R) (NIRS-2(p.26-31))
effects on coloration in alkaline-earth halides, spectra of, 18: 33643
effects on composition of liver lipids in mice, 18: 33360
effects on cotton seed, 18: 33333
effects on desoxyribonucleic acid, 18: 33275(R) (NYO-910-2)
effects on DNA in peas, 18: 33356
effects on electric properties of antimony-doped germanium, annealing of, 18: 34238
effects on electrolyte distribution in rat blood, 18: 33272(R) (NIRS-2(p.31-42))
effects on electrodes in nickel–cadmium batteries, 18: 34213(R) (AI-64-11)
effects on extracts of cellular structures of sugar beet leaves by seed exposure, 18: 33314
effects on fish and rabbits, development of conditioned reflex to, 18: 33366
effects on fused chloride and fluoride salts, 18: 34050(R) (ORNL-3626 (p.59-164))
effects on glycerinated mitochondria contraction, 18: 33270(R) (NIRS-2(p.23-6))
effects on hemolysis and enzymatic changes in stored blood, 18: 33345
effects on histidine decomposition in mouse liver, 18: 33359
effects on hydroponically-grown corn, 18: 33997
effects on lipid, nucleic acid, and protein synthesis in rat spleen, 18: 33382
effects on magnetic amplifier control devices for nuclear ramjets, 18: 33825 (AD-435095)
effects on mouse adrenal glands, 18: 33367
effects on mouse central M-choline reactive system, 18: 33368
effects on mouse typhoid immunity, 18: 33369
effects on nervous system in cats and rats, 18: 33278 (STI/DOC/10/28

(p.39-66))
effects on optical absorption of F and K bands in rubidium chloride, 18: 34306
effects on rabbit blood pressure, 18: 33364
effects on rat adrenal gland absorption, 18: 33357
effects on *Saccharomyces cerevisiae* strains of yeasts, 18: 33393
effects on sodium chloride, Zeeman effect in color-center, 18: 33644
effects on stability of barium sulfate colloids, 18: 33449(R) (NIRS-2 (p.15-19))
effects on strawberry grey rot, 18: 33998
effects on structure of nucleic acids, 18: 33277 (STI/DOC/10/28(p.21-38))
effects on structure of polypropene, 18: 34243
effects on tree growth, 18: 33282 (TID-20876)
emission from Coulomb-excited nuclei, angular distributions in, 18: 34965
emission in 0^+–0^+ transitions, two-photon, 18: 34752(R) (CU(PNPL)-234)
genetic effects in cotton seeds, 18: 33313
mutagenic effects in T2 bacterophage, 18: 33297
mutagenic effects on carnations, 18: 33302
mutagenic effects in Drosophila, effects of arginine on, 18: 33371
mutagenic effects on barley seeds, 18: 33375
polymerization induced in polyisobutylene by, in presence of allyl acrylate, 18: 33652
polymerization modification of acrylonitrile in acetone and other solvents, 18: 33650
polymerization of solid 3,3-*bis*-chloromethyloxatane, catalytic effects of inorganic solids on, 18: 33651
polymerization of acrylonitrile with methyl furan induced by, infrared spectra of products in, 18: 33670
polymerization of with acrylic and methacrylic acid menthol esters induced by, mechanism of, 18: 33674
polymerization of ethylene induced by, induction period, rate, and weight of polymer in, 18: 33649
reactions (γ,n) and (γ,p) with calcium-40, resonances in, 18: 34629
reactions (γ,n) with nuclei ($50 < A < 200$), 18: 34935
reactions (γ,p) with silicon-28 up to 21 Mev, cross sections for, 18: 34901
reactions with lithium-drifted silicon detectors, damage effects in, 18: 33914
reactions with materials in reactors, heat generation from, 18: 34236
reactions with plastic scintillators-scintillation output from, 18: 33638
scattering at small angles, coherent, 18: 35053
scattering by crystals, diffraction in nuclear resonant, 18: 34929
scattering by nuclei at 280 kev, Z dependence of Rayleigh, 18: 34417
strawberry preservation using, 18: 33993
transmission through thin slabs, 18: 35051
transmission through cylindrical and spherical shields from point source, Monte Carlo calculations for, 18: 35052
use in automatic separation of potatoes from ground lumps, 18: 33991(T) (AEC-tr-6399(p.277-85))
velocity of, from moving source, 18: 34659
yields in proton reactions (p,γ) with aluminum, 18: 34917

GAMMA SHIELDING
analysis of, point-to-point kernel, 18: 35055
gamma transmission through thin slabs of, 18: 35051
properties of cylindrical and cylindrical, for point source, 18: 35052

GAMMA SOURCES
calculations for density meter for pulp, 18: 33847(T) (AEC-tr-6399 (p.124-37))
content in rain water, 18: 33805(R) (NIRS-2(p.57-67))
counting of, automatic sample changer for, 18: 33716
determination of mixed, spectrometer channel ratios in, 18: 33489
dosimetry of internal, method for absorbed, 18: 33821
measurement of liquid, automatic system for, 18: 33982(P)
shielding of point, cylindrical and spherical, 18: 35052
use in level indicator for tower flooding analysis, 18: 34000

GAMMA SPECTRA
analysis of complex, with instrumental instability compensation, 18: 33926
compilation for 300 isotopes, 18: 34755 (IDO-16880-1)
compilation for 300 radioisotopes, 18: 34756 (IDO-16880-2)

GAMMA SPECTROMETERS
analysis with, channel ratio in two-source, 18: 33489
design and performance. 18: 34755 (IDO-16880-1)
design of coincidence, using anti-Compton annulus, 18: 33950
development of semiconductor lithium-drifted diodes as, 18: 33912

GAMMA SPECTROSCOPY
use in analysis of urine and feces for gamma-emitting radioisotopes, 18: 33264

GARIGLIANO POWER REACTOR
development, quarterly summary No. 7, 18: 35147(R) (GEAP-4645)

GAS ANALYZERS
use of ionization chamber as, for ternary mixtures, 18: 33471(T) (AEC-tr-6399(p.92-7))

GAS COOLED REACTORS
charge pan support arrangement for graphite-moderated, 18: 35102(P)
design of core assembly for high-temperature, 18: 35189(P)
design of graphite-moderated carbon dioxide-, with granular moderator, 18: 35123(P)
design with horizontal moderator and bracing means, 18: 35088(P)
fuel channel heat transfer and maximum temperatures in, Magnox, 18: 35182
fuel element assembly design for, 18: 35134(P)
fuel element design for, 18: 35136(P)
heat exchangers for power, survey, 18: 35150 (NYO-9789)
loading machine for, design of, 18: 35106(P)
moderator block structure, 18: 35096(P)
optimization of power, 18: 35179
pressure vessel shield design for, for protection against thermal stresses, 18: 35109(P)
review and survey of commercial power, 18: 35160 (TID-8540(p.1-69))
thermal barrier for concrete vessel of, 18: 35104(P)

GAS FLOW
magnetogasdynamic, theory of, 18: 35035
magnetogasdynamic, theory of two-dimensional, 18: 34321
magnetohydrodynamic hypersonic, past a blunt or nonblunt body, 18: 34272 (NASA-CR-88)
particle collisions in gas-particle mixtures, 18: 33749
theory of shock-tube, kinetic, 18: 34279 (NP-14186)
through porous materials, rates of, 18: 33747

GASEOUS FUEL REACTORS
neutron flux distributions in mockup of, 18: 34731 (NASA-CR-54110)

GASEOUS IONS
recombination of, rate constants for, 18: 33555

GASES
analysis of radioactive, by scintillation counting, 18: 35246(R) (MLM-1196)
analysis of ternary mixtures, using ionization chamber, 18: 33471(T) (AEC-tr-6399(p.92-7))
density and energy of electron, 18: 34644
density measurements on, device for, 18: 33874(P)
determination in metals, vacuum fusion, 18: 33491
detonation wave reflection by, 18: 34324
detonation-wave propagation through ideal, solutions for, 18: 34318
electric conductivity of, in pulsating combustion chamber, 18: 34296
electric discharge in, induced by laser beams, 18: 34350
electron distribution function in slightly ionized, 18: 34457
electron drift velocities in, in electric fields, 18: 34322
equation of state for, with weak long-range positive potential, 18: 34655
equation-of-state of ideal nonrelativistic Fermi-Dirac, 18: 34645
flow rates through porous materials, 18: 33747
free energy of Fermi, 18: 34654
hydromagnetic wave coupling to acoustic and electromagnetic waves at plasma interface with, 18: 35004
ionization by proton impact, electron angular and energy distributions from, 18: 34404(R) (COO-1277-5)
ionization by relativistic electron beams, effects of pressure and temperature on, 18: 34270 (LAL-1093)
ionization by shock waves, far-flow approximations for precursor, 18: 34288
kinetics of, derivation of generalized Boltzmann equation for, 18: 34315
molecule collisions in, eigenfunctions of Boltzmann operator for, 18: 34331
particle reactions in flow of gas-particle mixtures, 18: 33749
partition function of quantum, expansion formula for, 18: 34664
phase separator for, for space applications, 18: 33701
shock structure in discrete-velocity, 18: 34325
sorption on metals, review of techniques in studies on, 18: 33454
space-charge motion in neutral, transient, 18: 34364
theory of electron, particle-hole exchange scattering in, 18: 34342

GASTROINTESTINAL TRACT
radiation effects on epithelium histopathology in fish, x, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on food retention in, in rats, 18: 33277 (STI/DOC/10/28(p.21-38))
radioinduced lesions of, free tracheal graft for, 18: 33219

GENERAL ELECTRIC TEST REACTOR
in-pile loop operation for testing uranium dioxide fuel in pressurized water, 18: 35127(R) (GEAP-3771-13)

GENERATORS
design and development of turbogenerator for space vehicle electric power systems, 18: 35197(R) (64SD700)

GENES
frequency of recessive, in consanguineous marriages, 18: 33273(R) (NIRS-2(p.42-8))
GENETICS
factors affecting radiosensitivity of mice, 18: 33281(R) (TID-20844)
of *Diplococcus pneumoniae*, 18: 33273(R) (NIRS-2(p.42-8))
radioinduced mutations in maize and wheat, 18: 33279(R) (TID-20823)
role of heredity in chromosomal diseases of human populations, 18: 33336
GEOCHEMISTRY
book: *Isotopic and Cosmic Chemistry*, 18: 33456
GEOLOGY
oxygen isotope geothermometry, 18: 33785
rubidium and strontium redistribution during metamorphism, 18: 33793
GEOMAGNETIC FIELDS
interactions with solar wind, boundary region in, 18: 34675
nuclear test effects on, 1962 Johnston Island, 18: 34676
oscillations of, hydromagnetic model for, 18: 34979 (UCRL-11077)
plasma trapping in simulated, 18: 34984
variations in 1-cps range, statistical study of, 18: 34670 (AD-437330)
variations of, effects of sunspot activity on, 18: 34387
GEOMAGNETIC STORMS
calculation of storminess, method for, 18: 34673
data on 1963 and early 1964, 18: 34391
effects on cosmic-ray intensity at 9 to 12 km, 18: 34464(T) (NASA-TT-F-126(p.180-6))
effects on cosmic-ray intensity variations, 18: 34465(T) (NASA-TT-F-126(p.187-93))
hydromagnetic wave emission following, statistical study of, 18: 34670 (AD-437330)
modulation of, lunar, 18: 34677
GEOPHYSICS
calculation of geomagnetic storminess, method for, 18: 34673
geoelectric prospecting techniques for on-site detection of underground explosions, 18: 33780 (NP-14145)
radiocarbon dating, accuracy of, 18: 33789
GERMANIUM
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
analysis for hydrogen, nitrogen, and oxygen, vacuum fusion, 18: 33491
determination in silicon, activation, 18: 33502
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
radiation effects on defects in, 18: 34216 (NASA-TN-D-2364)
radiation effects on thermoelectric properties of, 18: 34237
radiation effects on antimony-doped, annealing of gamma, 18: 34238
recombination of electrons and donors in, mechanism, 18: 34280(R) (NYO-2680-1)
GERMANIUM ISOTOPES Ge-70
fractionation in ratio with germanium-76 in chemical reactions, 18: 33626
GERMANIUM ISOTOPES Ge-76
fractionation in ratio with germanium-70 in chemical reactions, 18: 33626
GERMANIUM JUNCTIONS
performance of lithium-drifted p-i-n, as gamma pair spectrometers, 18: 33912
GERMANIUM OXIDES
reduction by hypophosphorus acid, isotopic fractionation of germanium-70 and -76 in, 18: 33626
GERMANIUM SYSTEMS
Ge–Te, specific heat and bulk superconductivity of, 18: 34711
GERMANY
fallout monitoring, 1962, 18: 33772
GLASS
analysis of, oxygen-isotope, 18: 33787
blowing on contaminated apparatus, diaphragm valve for, 18: 33718
preparation and properties of radioactive, for waste disposal, 18: 35234(R) (HW-81862)
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
sorptive properties for young fission products from solutions, 18: 33448 (IDO-14644)
GLASS TEXTILES
use as pulsed-coil magnet insulation, 18: 33717
GLOBULIN
radiation and burn injury effects on content of, in rats, 18: 33381
GLYCEROL
glycerol–3-methyl-1-butanol, immiscibility boundary, 18: 34131 (TID-20849)
GLYCINE SULFATES
radiation effects on shape of dielectric hysteresis loop in, 18: 34242
GLYCOLS
synthesis from methanol and nitrogen oxides from air, radiochemical, 18: 33629
GOLD
activation by thermal neutrons, self-shielding effects in, 18: 33488
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
argon and helium atomic beam scattering by, 18: 34420
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination in silicon, activation, 18: 33502
electron scattering by, energy loss mechanisms in relativistic, 18: 34258(R) (AD-417250)
neutron inelastic scattering cross sections, 18: 35060(R) (ANL-6904)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
neutron resonance integrals, 18: 35247(R) (NAA-SR-9700)
oxygen-16 reactions at 167 Mev, charged-particle emission in, 18: 34780 (UCRL-11349)
properties as diffusion barrier for refractory metals, 18: 34029(R) (AD-601740)
radiation effects on electric conductivity of, annealing electron, 18: 34249
radiation effects on, quenching of, 18: 35247(R) (NAA-SR-9700)
surface properties for molten chloride and fluoride salts, 18: 34050(R) (ORNL-3626(p.59-164))
GOLD ISOTOPES Au-191
electron conversion spectra, 18: 34786
GOLD ISOTOPES Au-197
argon-40 reactions (Ar-40, Ar-41) with, angular distributions in, 18: 34763 (JINR-P-1675)
argon-40 reactions (Ar-40, Cl-39) with, angular distributions in, 18: 34763 (JINR-P-1675)
lithium ion reactions (Li-6,α) at 33 and 61 Mev, 18: 34856
neon-20 reactions (Ne-20, Na-24) with, angular distributions in, 18: 34763 (JINR-P-1675)
neutron inelastic scattering by, analysis of, 18: 34910
GOLD ISOTOPES Au-198
beta decay of, analysis using silicon detectors, 18: 34752(R) (CU(PNPL)-234)
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
beta particles from, polarization of, 18: 34877
therapeutic use of, pleural-effusion, 18: 33439
GOLD SYSTEMS
C–Au, sorptive properties for krypton-85 as bremsstrahlung source, 18: 34287(T) (NP-tr-1160)
GONADAL HORMONES
radiation effects on biosynthesis of androgen, 18: 33316
GONADS
grafting of, in irradiated mice treated with hematopoietic cell injections, 18: 33277 (STI/DOC/10/28(p.21-38))
phosphatide content and metabolism in irradiated and normal rat, effects of ACTH and cortisone on, 18: 33256
radiation dose to, from diagnostic procedures, 18: 33419
radiation effects on zinc-65 uptake by mouse, x, 18: 33270(R) (NIRS-2(p.23-6))
radiation effects on embryonic death of rats, 18: 33280(R) (TID-20831)
radiation effects on androgen biosynthesis by, 18: 33316
radiosensitivity of human ovaries, 18: 33395
radiosensitivity of human testicles, 18: 33394
GRANITES
distribution of ancient gneiss, in Black Hills, 18: 33768
GRAPHITE
coating for protection at high temperatures, review, 18: 34043 (ML-TDR-64-173(Pt.I))
coating of, process for deposition of oxidation-resistant refractory, 18: 34116(P)
dehydration by helium purging, 18: 34050(R) (ORNL-3626(p.59-164))
heat transfer across contacting surface with tungsten, 18: 33735 (MIT-2079-2)
preparation and properties of, for high-temperature irradiation tests, 18: 34041 (HW-80752)
properties of, evaluation, 18: 34050(R) (ORNL-3626(p.59-164))
radiation damage in, removal by reirradiation and low-temperature annealing, 18: 34230
radiation effects on thermal conductivity of pyrolytic, neutron, 18: 34033(R) (BMI-1669(Del.))
radiation effects on, in fluoride salts molten, 18: 34050(R) (ORNL-3626(p.59-164))
radiation effects on dimensions of, 18: 34231
radiation effects on pyrolytic, at high temperatures, 18: 34232
reactions of nuclear grade, with carbon dioxide, review of thermal,

18: 33525 (HW-74663)
surface properties for molten chloride and fluoride salts, 18: 34050(R) (ORNL-3626(p.59-164))
GRAPHITE (IMPREGNATED)
development as fuel for HTGR, economics of, 18: 35176
GRAPHITE MODERATED REACTORS
charge pan support arrangement for gas-cooled, 18: 35102(P)
core support within concrete pressure vessel, 18: 35101(P)
design of carbon dioxide-cooled, with granular moderator, 18: 35123(P)
design with horizontal moderator and bracing means, 18: 35088(P)
economics of natural-uranium, for power, 18: 35170
moderator support structure, 18: 35100(P)
GRAPHITE SYSTEMS
graphite–uranium, reactivity temperature coefficients in lattices of, 18: 35118
GRAVIMETRIC ANALYSIS
instrumentation for micro-thermo-, 18: 35146(R) (GEAP-4601)
GRAVITATION
theory for, S-matrix, 18: 34658
theory of elementary particle motion in, geodesic postulate for, 18: 34335
GREAT BRITAIN
radiation dose to population of, diagnostic, 18: 33419
GROUND
radon content in air near, beta counting method for determing, 18: 34257
GROWTH
of Nostoc, effects of calcium, cobalt, molybdenum, and strontium on, 18: 33237
radiation effects on human, *in utero* exposure, 18: 33391
GUINEA PIGS
iodine-131 uptake by blood plasma, liver, muscles, renal organs, and skin of, 18: 33251
radiation effects on blood picture of, 18: 33363
radioinduced skin lesions of, effects of treatment with cigerol and linol, 18: 33413

H

HAFNIUM
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
corrosion by water under ATR conditions, 18: 34074 (IDO-24460)
determination using bromanilic acid, spectrophotometric, 18: 33498
effects on tantalum–tungsten alloys, 18: 34059(R) (WANL-PR(Q)-003)
fabrication of powdered, method for, 18: 34117(P)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
neutron resonance absorption cross sections, 18: 34883
HAFNIUM ALLOYS
Hf–Nb, phase studies on, 18: 34163
Hf–Nb–W–Y, welding of C-129Y, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Hf–Ta, corrosion by water under ATR conditions, 18: 34074 (IDO-24460)
HAFNIUM ISOTOPES
neutron resonance absorption cross sections, 18: 34883
HAFNIUM ISOTOPES Hf-176
energy levels of, vibration-rotation interactions in, 18: 34846
HAFNIUM ISOTOPES Hf-178
energy levels, 18: 34843
energy levels of, vibration-rotation interactions in, 18: 34846
HAFNIUM ISOTOPES Hf-180
energy levels of, vibration-rotation interactions in, 18: 34846
HALDEN BOILING REACTOR
noise measurements for Core I, 18: 35157 (TID-7679(p.449-68))
HALLAM POWER REACTOR
fuel elements for, equipment for examination of irradiated, 18: 35247(R) (NAA-SR-9700)
HAMSTERS
radiation effects on developing fetuses in, 18: 33322
radiation effects on sister chromatid exchange in chromosomes of hamster cells in culture, 18: 33329
radioinduced polyploidy in cell cultures of Chinese, x, 18: 33383
HANDBOOKS AND MANUALS
on radiation effects on electrical and electronic materials, 18: 34245
on refractory ceramics for aerospace structural applications, 18: 34129 (RTD-TDR-63-4102(Suppl.1))
HANFORD PRODUCTION REACTORS (D)
corrosion of aluminum surfaces by coolant in, half-reactor test for effects of pH on, 18: 35194 (HW-78964)
HANFORD PRODUCTION REACTORS (F)
cooling water treatment in, half-reactor test for effects of alum feed on corrosion in, 18: 35193 (HW-78431)
HANFORD PRODUCTION REACTORS (N)
steam generator tubing burst tests, 18: 35195 (HW-82233)
tube joint for, thermal stress analysis of zirconium–carbon steel, 18: 33694 (HW-76850)
HANFORD WORKS, RICHLAND, WASH.
contamination of ground air by stack emissions, 18: 33801 (HW-80204)
meteorological data for, 18: 33801 (HW-80204)
radioisotope separation from wastes for use as heat sources, 18: 33983 (HW-SA-3080(Rev.))
HARMONIC ANALYSIS
bounds on generalized Fourier coefficients, 18: 34020
HASTELLOY C
corrosion by titanium sponge at 900°C, 18: 33678(R) (ANL-6875)
HASTELLOY X
corrosion by titanium sponge at 900°C, 18: 33678(R) (ANL-6875)
properties of foils at high temperatures, mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)
radiation effects on claddings of, 18: 34032(R) (BMI-1668(Del.))
radiation effects on claddings of, 18: 34033(R) (BMI-1669(Del.))
radiation effects on claddings of, 18: 34034(R) (BMI-1672(Del.))
HAYNES 25 ALLOY
corrosion by water under ATR conditions, 18: 34074 (IDO-24460)
HEAD
radiotherapy of, injuries resulting from, 18: 33422
HEALTH PHYSICS
design of mobile whole-body counter, 18: 33802 (HW-80216)
tissue dose determination, methods for, 18: 33428
HEART
analysis for trace elements in human, neutron-activation, 18: 33457 (AE-146)
radiation effects on pericardium of, 18: 33327
HEAT
production in gamma reactions with materials in reactions, calculations for, 18: 34236
HEAT EXCHANGERS
design and development for liquid metals, 18: 35197(R) (64SD700)
design for Cambridge Synchrotron, 18: 34367 (CEAL-1000)
survey for gas-cooled power reactors, 18: 35150 (NYO-9789)
HEAT EXCHANGERS (GAS-LIQUID)
design for nuclear aircraft power plants, 18: 33754(P)
HEAT EXCHANGERS (LIQUID-LIQUID)
development of sodium-heated steam generators, 18: 33741(R) (TID-20603)
pipes for, fabrication of, 18: 35093
HEAT TRANSFER
across contacting surfaces, analysis of resistance of, 18: 33735 (MIT-2079-2)
analysis during destructive pressure pulse in SPERT-ID, 18: 35223(R) (STL-372-6)
analysis during transients in fast liquid-metal-cooled reactors, 18: 35146(R) (GEAP-4601)
analysis in Inconel tubes, 18: 35153(R) (SRO-103)
analysis in 19-rod-bundle reactor fuel elements, 18: 35153(R) (SRO-103)
analysis of rocket engine, computer program for, 18: 33751
boiling burnout in reactor design, 18: 35162 (TID-8540(p.131-76))
burnout heat flux to steam–water mixtures in annulus, 18: 33730 (AERE-R-4352)
critical boiling in vertical pipes, 18: 33743
from plasmas in channels, 18: 33752
in fluid flow around rectangular cylinder, 18: 33748
in laminar flow in transverse magnetic field, 18: 34359
in rectangular channels with unequally heated walls, 18: 33746
in swirl flow with heated twisted tapes, 18: 33738 (ORNL-TM-894)
in transition boiling to rods in channel flow, 18: 33734(R) (GEAP-4646)
of liquid sodium between separated rod bunches, 18: 33744
HEAT TRANSFER SYSTEMS
development for boiling liquid metal studies, 18: 35060(R) (ANL-6904)
development of transition boiling loop, 18: 33734(R) (GEAP-4646)
transient behavior of loop, 18: 35060(R) (ANL-6904)
uses for analysis of kinetics of boiling-water reactors, 18: 33733(R) (EURAEC-1127)
void fraction measurement in water loops, 18: 33739 (RT/ING(64)-5)
HEATERS
description of air, with fast control response, 18: 33711 (AERE-M-1373)
HEAVY WATER REACTORS
design feasibility of, up to 8300 Mw(th), 18: 35143(R) (DP-915)
development, June 1964, 18: 35061(R) (DPST-64-83-6)
economics of natural-uranium, for power, 18: 35170
heat transfer burnout in light water-cooled, effects of rod spacing on, 18: 35061(R) (DPST-64-83-6)
lattice calculations for, methods for, 18: 35112 (RISÖ-81)

neutron density distributions in, calculations of, 18: 35143(R) (DP-915)
neutron flux and reactivity of, void effects on, 18: 35083
neutron lifetimes in heavy water-reflected, prompt, 18: 35116
physics of, 18: 35120
power history of, correlation with tritium activity in heavy water, 18: 35065 (STI/DOC/10/28(p.67-71))
review and survey of commercial power, 18: 35161 (TID-8540(p.71-129))
HELIUM
burnout in steady-state plasma of, 18: 35014
cesium optical pumping in, spin relaxation time in, 18: 33566
crystal stability of, three-body interactions in, 18: 34706
determination in argon in gas chromatography, electron drift velocity detector for, 18: 33476
diffusion in irradiated beryllia powder, 18: 34040(R) (GEMP-36A)
electric discharge in, spatial distribution of intensity in afterglow of, 18: 34310
electric discharge in, ion conversion rate and mobility in afterglow of, 18: 34351
electron energy levels of atomic, magnetic susceptibility of $^3S_1$, 18: 34438
electron wave functions in, 18: 34425
electron wave functions in, Gaussian correlation function for, 18: 34427
excitation by hydrogen atoms and protons, 18: 34445
excitation spectrum of liquid II, 18: 34702
film of liquid, thickness of moving, 18: 34716
heat transfer from plasma of, channel, 18: 33752
hydromagnetic wave motion in cylinder of, radial dependence of, 18: 35009
ionization by proton impact, electron angular and energy distributions from, 18: 34404(R) (COO-1277-5)
ionization by relativistic electron beams, effects of pressure and temperature on, 18: 34270 (LAL-1093)
microwave interaction in afterglow plasma of, 18: 35015
performance as refrigerant for cryogenic magnets, 18: 34682(R) (NBS-8407)
photon scattering by, neutron polarizability from, 18: 34538
positron annihilation in, 18: 34752(R) (CU(PNPL)-234)
quenching behavior of tungsten in, 18: 34138
reactions with inert-gas atoms, van der Waals forces for, 18: 34345
scattering of atomic beams of, by gold films, 18: 34420
shock reflection against end plate in high-explosive tube containing, 18: 34332
slowing down in helium and hydrogen, partial stopping power for, 18: 34456
solubility in uranium dioxide at 1200 and 1300°C, 18: 34055 (UCRL-11043)
spectra of, atomic and molecular emission in, 18: 34419
stopping power for helium atoms and ions, partial, 18: 34456
theory of liquid, as degenerate boson system, quantum-statistical, 18: 34337
theory of liquid, quantum-statistical, 18: 34338
theory of liquid, quantum-statistical, 18: 34339
thermodynamic properties of, at high temperatures, 18: 34289
vorticity in liquid, onset and growth of, 18: 34691
wave equations for, energy eigenvalues of ground-state, 18: 34660
NH_3–He, electron temperatures in afterglow plasma of, 18: 34999
HELIUM IONS
conversion rate and mobility in discharge afterglow, 18: 34351
effects on SAP foils at 30 kev, 18: 34038 (EUR-1833.e)
production and measurement of beams of negative, 18: 34381
reactions (He-3,p) with calcium-42 at 10 to 15 Mev, 18: 34960
reactions with bismuth-209 and lead-206, fragments in fission, 18: 34880
reactions with ethylene molecules at 200 and 400 kev, mass spectra of fragments from, 18: 34433
scattering by rare gases at 80 kev, energy losses from, 18: 34416
slowing down in helium and hydrogen, partial stopping power for, 18: 34456
HELIUM ISOTOPES
content in Renazzo chondrite, 18: 34390
HELIUM ISOTOPES He-3
analysis for tritium by scintillation counting, 18: 35246(R) (MLM-1196)
emission in oxygen-16 reactions with nuclei at 167 Mev, spectra of, 18: 34780 (UCRL-11349)
form factors, 18: 34912
hyperfine structure of ^3D levels of, 18: 34903
meson (μ^-) capture at 100 to 120 Mev/c, rate for, 18: 34776 (UCRL-11004)
production in deuteron interactions with deuterons and nucleons, 18: 34544
reactions (He-3,pγ) with fluorine-19 at 4.7 and 5.2 Mev, angular correlations for, 18: 34849
reactions (He-3,p) with calcium-42 at 10 to 15 Mev, 18: 34960
reactions (He-3,p) with nuclei at 13.9 and 31.2 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
scattering by nuclei, diffraction mechanism for elastic, 18: 34848
separation from superfluid helium-4 by filtering, 18: 35246(R) (MLM-1196)
thermal boundary resistance between solids and, below 1°K, 18: 34697
HELIUM ISOTOPES He-4
acoustic properties of helium-II, fourth sound, 18: 34725
deuteron elastic scattering at 2.9 to 11.5 Mev, 18: 34867
deuteron elastic scattering at 25 Mev, differential cross section for, 18: 34771 (NP-14175)
emission in oxygen-16 reactions with nuclei at 167 Mev, spectra of, 18: 34780 (UCRL-11349)
meson (μ^-) capture at 100 to 120 Mev/c, rate for, 18: 34776 (UCRL-11004)
separation of superfluid, from helium-3 by filtering, 18: 35246(R) (MLM-1196)
thermal boundary resistance between solids and, below 1°K, 18: 34697
thermal conductivity of solid, 18: 34718
HELIUM SYSTEMS
He–H, electron scattering by, Cherenkov radiation and ionization from, 18: 34258(R) (AD-417250)
HEMATOLOGY
automatic pattern-recognition techniques for blood cells, 18: 35256
HEMATOPOIETIC SYSTEM
radiation effects on liberation of polydesoxyribonucleotide from cells in, 18: 33308
radiation injuries of, role of erythropoietin in recovery from, 18: 33277 (STI/DOC/10/28(p.21-38))
radiosensitivity of, in fetal mice, 18: 33344
HEME
radiation effects on synthesis of, in rabbits, 18: 33400
synthesis by bone marrow cells, 18: 33242
HEMOGLOBIN
radiation effects on levels in regenerating rat liver, x, 18: 33301
radiation effects on guinea pig, 18: 33363
radiation effects on synthesis of, in rabbits, 18: 33400
synthesis of, in rat erythrocytes and precursors, 18: 33234 (UCRL-11459)
HEMORRHAGE
radioinduced in animals and man, 18: 33291
HERMEX PROCESS
description, 18: 33683 (TID-8540(p.411-76))
HETEROGENEOUS REACTORS
excursions in water-cooled, pressure pulses and voids from, 18: 35068(R) (STL-6312)
excursions in water-cooled, steam-void formation during, 18: 35223(R) (STL-372-6)
hydrodynamic characteristics of boiling-water, 18: 35067(R) (STL-372-3)
neutron spectra in, computer program for, 18: 34730 (KR-77)
5-HEXENAL
yields in gamma radiolysis of liquid cyclohexanone, 18: 33623
HIGH-ALTITUDE EXPLOSIONS
detection and identification of, techniques for, 18: 34251
effects of nuclear, on vlf phase anomalies, 18: 34250 (AWRE-O-35/64)
effects on watersheds, evaluation of, 18: 33811
neutron spectra from 1962 nuclear, 18: 34751 (CONF-481-71)
HIGH-PRESSURE SYSTEMS
study of knock-off tube as quick pressure-release mechanism, 18: 33829 (NOLTR-63-134)
HIGH TEMPERATURE SEPARATION PROCESSES
development of pyrometallurgical, for irradiated fuels, 18: 33683 (TID-8540(p.411-76))
HIPPURIC ACID, *o*-IODO-, SODIUM SALTS
iodine-131 retention by labeled, 18: 33646
HIROSHIMA
tuberculosis frequency in, 18: 33225
HISTAMINE
radiosensitivity effects in mice, x, 18: 33414
HISTIDINE
radiation effects on decomposition of mouse liver, gamma, 18: 33359
HISTOLOGY
radiation effects on fish intestinal epithelium, x, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on fish adrenal cortex, x, 18: 33272(R) (NIRS-2(p.31-42))
HOLMIUM
electric conductivity at room temperature to melting point of, 18: 34162
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
neutron total cross sections, 18: 33678(R) (ANL-6875)

HOMOGENEOUS REACTORS
fuel beads for, method for production of glass, 18: 35138(P)
fuel solution purification in circuit of, 18: 35084(P)
HORMONES
effects of splenin and synestrol on radiation effects on blood picture and survival of mice, 18: 33416
radiation effects on sympathin content in rat brain, effects of aminazine on, 18: 33325
HORSES
iodine-131 uptake by blood plasma, liver, muscles, renal organs, and skin of, 18: 33251
HUNGARY
fallout monitoring, 1961 and 1962, 18: 33771
HYDRAULICS
integral equations for classical fluids and lattice gas, 18: 34336
HYDRAZINE NITRATES
surface temperature of catalyzed burning, measurements on, 18: 33581
NH_4NO_3–hydrazine nitrate, surface temperature measurements on catalyzed burning, 18: 33581
HYDRIODIC ACID
potassium scattering by crossed beams of, elastic and reactive cross sections for, 18: 33560
HYDROAROMATIC COMPOUNDS
preparation with increased stability for use as reactor coolants, 18: 33616(P)
HYDROCARBONS
analysis for sulfur by x-ray absorption, instrument for, 18: 33472(T) (AEC-tr-6399(p.98-114))
preparation with increased stability for use as reactor coolants, 18: 33616(P)
HYDROCHLORIC ACID
potassium scattering by crossed beams of, elastic and reactive cross sections for, 18: 33560
radiolysis of gaseous, effects of bromine and chlorine on hydrogen formation in gamma, 18: 33625
HYDRODYNAMICS
analysis in boiling-water heterogeneous reactors, 18: 35067(R) (STL-372-3)
HYDROFLUORIC ACID
heat of formation, 18: 33678(R) (ANL-6875)
nuclear magnetic shielding in, theory of, 18: 33563
solvent properties for cerium, 18: 33504
HF–H_2O, phase equilibria with molten fluoride salts, 18: 34050(R) (ORNL-3626(p.59-164))
HF–TBP, solvent properties for niobium and tantalum, 18: 33688
HYDROGEN
binding in organic moderators, effects of, 18: 34734
determination in argon in gas chromatography, electron drift velocity detector for, 18: 33476
determination in heavy water, spectrophotometric, 18: 33539
determination in metals, vacuum fusion, 18: 33491
determination in metals, gravimetric, 18: 33538
determination in refractory metals, review of methods for, 18: 33515
determination in refractory metals, review of methods for, 18: 33516
determination in titanium and zirconium and their alloys, equipment for, 18: 33511
determination in zirconium using dosivac, 18: 34060(T,R) (EURAEC-1062)
determination of active, by NMR spectrometry, 18: 33475
effects on lubricating properties of fused fluoride coatings on chromium–nickel alloy, 18: 33695 (NASA-TN-D-2348)
electron exchange scattering by atomic, 18: 34446
electron reactions at 1.7 to 3.5 ev, vibrational excitation in, 18: 34440
electron scattering by, Cherenkov radiation from, 18: 34258(R) (AS-417250)
electron wave functions in, Gaussian correlation function for, 18: 34427
embrittlement effects on zirconium alloys containing copper, iron, nickel, or niobium, 18: 34169
exchange with deuterium, development of equipment for studying, 18: 34282(R) (TID-20837)
exchange with deuterium in organic compounds, potential-energy surfaces in, 18: 33573
heat transfer from plasma of, channel, 18: 33752
hydrogen ion reactions at 20 Mev, dissociation in, 18: 34408 (UCRL-11249)
hydromagnetic wave motion in cylinder of, radial dependence of, 18: 35009
hyperfine structure interval for, 18: 34921
ionization by protons, energy loss per ion pair in, 18: 35060(R) (ANL-6904)
ionization by relativistic electron beams, effects of pressure and temperature on, 18: 34270 (LAL-1093)
isotope exchange with water, poisoning of platinum–carbon catalyst during, 18: 33527 (IFA-28-IS)
liquefier for, design of, 18: 34689
magnetic moment and susceptibility of molecular, centrifugal and vibrational effects of rotational, 18: 34436
nuclear magnetic resonance of solid, at 1.5 to 4.2°K under high pressures, 18: 34260 (AD-601933)
nuclear magnetic shielding in, theory of, 18: 33563
ortho-para conversion in solid, 18: 34260 (AD-601933)
photoabsorption and photoionization cross sections of, from 580 to 1000 Å, 18: 34421
photon reactions with atomic, recoil distribution from electron pair production in, 18: 34439
positron annihilation in atomic, 18: 34752(R) (CU(PNPL)-234)
production of atomic, collisional excitation and Lorentz ionization in, 18: 34408 (UCRL-11249)
proton reactions with atomic, distorted-wave approximation for resonant charge-transfer, 18: 34447
proton reactions with excited atomic, matrix elements for charge-exchange, 18: 34432
proton reactions with excited atomic, cross sections for charge-exchange, 18: 34434
radiolysis in presence of deuterated hydrocarbons, proton transfer reactions of H_3^+ in, 18: 33639
reactions of mesic atoms of, with carbon, 18: 34947
reactions on helium, excitation in, 18: 34445
reactions with alkaline earth sulfates, 18: 33529 (ORNL-3334(Pt.II))
safety in handling gaseous and liquid, development of room inerting technique for, 18: 33804 (LADC-6432)
separation from hydrogen tritides by gas chromatography, 18: 34011
spectra of plasma of, emission line profiles in, 18: 34983
stopping power for helium atoms and ions, partial, 18: 34456
vapor pressure of equilibrium and normal, at 20 to 32°K, 18: 33588
yields in gamma radiolysis of liquid cyclohexanone, 18: 33623
yields in gamma radiolysis of gaseous hydrochloric acid, effects of bromine and chlorine on, 18: 33625
yields in radiolysis of calcium acid sodium phosphates, 18: 33645
HYDROGEN IONS
effects on SAP foils at 30 kev, 18: 34038 (EUR-1833.e)
electron wave functions in, 18: 34425
production and measurement of beams of negative, 18: 34381
reactions with ethylene molecules at 200 and 400 kev, mass spectra of fragments from, 18: 34433
reactions with hydrogen molecules at 20 Mev, dissociation in, 18: 34408 (UCRL-11249)
vibrations of negative, in calcium fluoride, 18: 34262 (AFCRL-64-284)
HYDROGEN ISOTOPES
abundance of solar flare-produced, nuclear emulsion study of, 18: 34382 (NP-14141)
biological effects of, nuclear-man, 18: 33258
HYDROGEN PEROXIDES
effects on frog retina, 18: 33343
effects on reactivation of uv irradiated polyuridylic acid, 18: 33392
yields in thymidine radiolysis, 18: 33658
HYDROGEN SYSTEMS
BCl_3–H–SiCl, reaction with boron–molybdenum–silicon systems, 18: 34146
D–H, magnetic moment and susceptibility of molecular, 18: 34436
He–H, electron scattering by, Cherenkov radiation and ionization from, 18: 34258(R) (AD-417250)
H–U, thermal neutron spectrum of, 18: 34734
HYDROGEN TRITIDES
separation from hydrogen by gas chromatography, 18: 34011
HYDROLYSIS
reaction mechanisms in, analysis of tracer techniques in studies on, 18: 33985
HYDROMAGNETIC WAVES
damping at ion cyclotron resonance in plasma, Landau and collision, 18: 34974 (NP-14153)
emission and propagation in magnetosphere, statistical study of, 18: 34670 (AD-437330)
interactions with acoustic and electromagnetic waves at plasma-gas interface, 18: 35004
motion in deuterium, helium, and hydrogen in cylindrical geometry, radial dependence of, 18: 35009
production in plasma primary-wave interactions, 18: 34967 (AFCRL-63-786)
propagation by oscillating conducting boundary, 18: 34328
resonances in hot nonuniform positive column, 18: 34975 (NP-14194)
resonances in hot nonuniform positive column, 18: 34976 (NP-14195)
HYDROPEROXIDES
yields in thymidine radiolysis, 18: 33658

HYPERFRAGMENTS
binding energies of, with two- and three-body forces, 18: 34857
binding energy of, three-body p-shell, 18: 34878
HYPERONS
decay of, nonleptonic, 18: 34609
production of Y*, in ($\bar{K}$-N) interactions, 18: 34571
HYPERONS (Λ)
binding energies in hypernuclei, 18: 34857
binding in hypernuclei, 18: 34878
interactions with hyperons (Λ) including repulsive core, 18: 34607
magnetic moment, 18: 34580
photoproduction on protons, dispersion relations for, 18: 34536
HYPERONS (Λ^0)
decay, 18: 34566
HYPERONS (Ω^-)
decay of, leptonic, 18: 34587
production in hyperon (Ξ)–meson ($\bar{K}$) interactions, 18: 34568
HYPERONS (Σ)
photoproduction, 18: 34566
HYPERONS (Σ^+)
magnetic moment, 18: 34591
magnetic moment of, method for determining, 18: 34623
HYPERONS (Ξ)
interactions with mesons ($\bar{K}$), hyperon (Ω^-) production in, 18: 34568
resonance (Ξ-π) at 1530 Mev, parity and spin of, 18: 34517 (UCRL-11436)

I

IMAGE BRIGHTNESS INTENSIFIERS
development, 18: 33906
development, 18: 33907
development for bioluminescence microscopy, 18: 33221
development for uv radiation, 18: 33908
performance, 18: 33909
IMIDAZOLE
derivatives of, radiosensitivity effects on mice, 18: 33406
IMMUNE REACTIONS
adoptive transfer of sensitivity to allogenic or xenogenic skin grafts in irradiated mice, 18: 33388
radiation effects on mouse and rabbit, gamma and x, 18: 33369
radiation effects on, effects of temporary chimerism in rats, 18: 33387
IMPACT SHOCK
flat-faced projectiles, compressed gas gun for planar, 18: 33756
recording of, coaxial electric discharge pins for, 18: 33862
IN-PILE LOOPS
operation of pressurized-water, for uranium dioxide fuel testing, 18: 35127(R) (GEAP-3771-13)
INCONEL
cavitation by liquid sodium, 18: 34075 (NASA-CR-54071)
compatibility with beryllium–thorium–uranium alloy at 1500°F, 18: 34032(R) (BMI-1668(Del.))
compatibility with beryllium–thorium–uranium alloys and carbon–thorium–uranium systems, 18: 34034(R) (BMI-1672(Del.))
compatibility with beryllium–thorium–uranium alloy, 18: 34033(R) (BMI-1669(Del.))
corrosion by titanium sponge at 900°C, 18: 33678(R) (ANL-6875)
heat transfer in tubes of, 18: 35153(R) (SRO-103)
reactions with plutonium nitride, 18: 34032(R) (BMI-1668(Del.))
welding to monel, method for, 18: 35093
welding to Zircaloy-2, explosive, 18: 34033(R) (BMI-1669(Del.))
welding to Zircaloy-2, explosive, 18: 34034(R) (BMI-1672(Del.))
INCONEL X
corrosion by water under ATR conditions, 18: 34074 (IDO-24460)
INDIAN OCEAN
radioactivity during 1959–1960, 18: 33779
INDIUM
activation by thermal neutrons, self-shielding effects in, 18: 33488
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
determination in silicon, activation, 18: 33502
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
indium-15 NQR in, electric field gradient from, 18: 33585
neutron detection and measurement using, method for, 18: 33978(P)
neutron elastic scattering cross sections of natural, 18: 35060(R) (ANL-6904)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
performance as dopant in lithium-drifted silicon junctions, ion-pairing in, 18: 33922
spectra of, x-ray L-absorption and -emission, 18: 34412
thermal resistance at boundaries of sapphire with normal and superconducting, at 1.1 and 2.1°K, 18: 34699
x-ray L-emission spectrum, 18: 34410
INDIUM ALLOYS
In–Pb, superconductivity of, surface effects on, 18: 34683(R) (NP-14136)
Sb–In, radiation damage in, electron, 18: 34240
Sb–In–Sn, superconductivity in, 18: 34707
INDIUM ISOTOPES In-113
neutron capture and inelastic scattering by, cross sections for, 18: 34962
INDIUM ISOTOPES In-115
neutron capture and inelastic scattering by, cross sections for, 18: 34962
nuclear quadrupole resonance in indium, electric field gradient from, 18: 33585
proton reactions ($p,p\pi^+$) at 130 and 200 Mev, yields from, 18: 34946
INDIUM ISOTOPES In-116
neutron activation cross section ratio for, corrections to thermal, 18: 34884
INDIUM OXIDES
In_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
In_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
INDIUM TELLURIDES
superconductivity, 18: 34707
5-INDOLOL, 3-(2-AMINOETHYL)-
radiation effects on secretion of, in rats, 18: 33277 (STI/DOC/10/28 (p.21-38))
INDUSTRIAL MANAGEMENT
civilian defense measures for, 18: 33814
INFRARED RADIATION
absorption by superconductors, collective excitations in, 18: 34720
plasma diagnostics with, from helium-neon maser, 18: 35013
INFRARED SPECTROMETERS
design of interference, for isotopic analysis of water–water-d_2 mixtures, 18: 33460 (CEA-R-2440)
INOR-8
corrosion in fluoride volatility process, 18: 34034(R) (BMI-1672(Del.))
performance in molten salt reactors, evaluation of, 18: 34050(R) (ORNL-3626(p.59-164))
radiation effects on, 18: 34050(R) (ORNL-3626(p.59-164))
INSTRUMENTATION
automatic, for nuclear fuel reprocessing plant, 18: 33856
review of in-pile, 18: 35089 (TID-8540(p.177-211))
INSTRUMENTS
design for use in mixed-oxide ceramic fuel test capsules, 18: 35146(R) (GEAP-4601)
design of gamma-ray, for automatic operation of coke delivery machines, 18: 33987(T) (AEC-tr-6399(p.202-6))
design of radiometric automatic control devices, using standard block components, 18: 33843(T) (AEC-tr-6399(p.1-9))
design of radiometric, for detecting burnout in cooling pipes, 18: 33846(T) (AEC-tr-6399(p.30-42))
design of radiometric, for automatization of cycle of crushing and classification of ores, 18: 33988(T) (AEC-tr-6399(p.227-42))
radiometric automatic control devices, dosing system for, 18: 33851(T) (AEC-tr-6399(p.177-85))
radiometric, applications in building-materials industry, 18: 33852(T) (AEC-tr-6399(p.196-201))
radiometric, statistical characteristics of feedback loop in, 18: 33844(T) (AEC-tr-6399(p.10-20))
radiometric, use of scintillation detectors with light ducts in, 18: 33850(T) (AEC-tr-6399(p.163-72))
use of radiometric control devices for automation in Russian chemical industry, 18: 33990(T) (AEC-tr-6399(p.258-76))
INTERFEROMETERS
development of modulated-reflection, for plasma electron density changes, 18: 35022
INTERMOLECULAR FORCES
of inert gases, 18: 34345
INTERNAL COMBUSTION ENGINES
exhaust oxidation using depleted urania as catalyst, 18: 33610(P)
INTESTINE
iron absorption in, double tracer method for measurement, 18: 33440
radiation effects on formation of lipid oxidation products in homogenates of rat, 18: 33305
IODIDE IONS
reactions with methyl iodide, calculated carbon-13 and deuterium isotope effects in, 18: 33612 (BNL-8066)
IODINE
beta scattering by, measurement of saturated backscattering from, 18: 35057
metabolism, 18: 33328

metabolism in rat thyroid, effects on protein synthesis, 18: 33212(R) (NYO-2570-1)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
reactions with Zircaloy-2 at 250 to 700°C, 18: 35127(R) (GEAP-3771-13)
recombination in argon and helium, rates of, 18: 33555
sorption by aerosol particles of, 18: 33805(R) (NIRS-2(p.57-67))
uses of radio-, radiobiological aspects of, 18: 33420

IODINE IONS
charge exchange in Mercury vapor, cross section for single, 18: 34448
electron energy levels of, quadrupole antishielding factors for, 18: 34442

IODINE ISOTOPES I-124
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)

IODINE ISOTOPES I-125
production from xenon-124 on charcoal, 18: 34007(R) (ORNL-TM-890)

IODINE ISOTOPES I-126
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)

IODINE ISOTOPES I-131
buildup in research reactors, 18: 35228
determination in liquids, gamma spectrometric, 18: 33485
determination in urine and feces, gamma spectrometric, 18: 33264
determination of physico-chemical state in liquid media, by paper electrophoresis and radioactivity recording, 18: 33590
formation in neutron irradiated tellurium compounds, chemical state of, 18: 33661
incorporation in hippuran, instability of, 18: 33646
incorporation in iodobenzoic acid, 18: 33614
production from irradiation uranium oxide using distillation, 18: 33620 (NP-14187)
separation from air by activated charcoal, 18: 33808(T) (AEC-tr-6459)
therapeutic use of, dose to medical personnel from, 18: 33421
tracer uses for edema, 18: 33231(R) (NIRS-2(p.49-56))
uptake by blood plasma, liver, muscles, renal organs, and skin of animals and chickens, 18: 33251
uptake by eggs from chickens, 18: 33255
uptake by turtles, 18: 33254
uptake in rats, 18: 34403
uptake of triiodothyronine-labeled, by resin uptake of, 18: 33437

IODINE ISOTOPES I-132
buildup in research reactors, 18: 35228

IODINE ISOTOPES I-133
buildup in research reactors, 18: 35228

IODINE ISOTOPES I-134
buildup in research reactors, 18: 35228

IODINE ISOTOPES I-135
buildup in research reactors, 18: 35228

ION BEAMS
interactions with environment in ground testing of rocket engines, 18: 34261 (AEDC-TDR-64-127)

ION EXCHANGE MATERIALS
electron spin resonance of manganese(II) in zeolites, 18: 34268 (IFA-IS-27)
performance of Decalso for cesium in sodium ion-containing wastes, 18: 34006(R) (ORNL-TM-889)
preparation of, using wood as raw material for, 18: 35238 (STI/DOC/10/28(p.9-20))
sorptive properties of clinoptilolite for chromium and cobalt from solutions, 18: 35235 (IDO-12036)

ION EXCHANGERS
design for reactor feed water purification, 18: 33713
Peclet numbers and retardation factors for columns, 18: 33684

ION PUMPS
operation of sputter-, of Penning and magnetron configurations, 18: 33760

ION SOURCES
description of duoplasmatron, 18: 34381
design and performance of duoplasmatron, 18: 34377
development for ion engine propulsion, 18: 35216

IONIZATION CHAMBERS
design for electron drift velocity detection, 18: 33476
review, 18: 33967
use for determining x-ray total beam energy, 18: 34274(R) (NIRS-2(p.3-15))
use in analysis of ternary gas mixtures, 18: 33471(T) (AEC-tr-6399 (p.92-7))

IONOSPHERE
diffusion in, geomagnetic anomaly and, 18: 34678
hydromagnetic wave propagation in, from geomagnetic field fluctuations, 18: 34670 (AD-437330)
radio wave reflection at vlf by, effects of high-altitude nuclear explosion on, 18: 34250 (AWRE-O-35/64)
wave propagation in, transverse, 18: 34679

IONS
energy of n-electron systems, 18: 34353
motion in neutral gases, transient space-charge, 18: 34364
recombination of molecular positive, with electrons, 18: 34259 (AD-434907)
trajectories in Brownian motion in attractive force field, trapped, 18: 34311

IRIDIUM
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))

IRIDIUM CHLORIDES
oxidation of iron, molybdenum, and tungsten cyanide complexes by electron-transfer reactions in, 18: 33550

IRIDIUM COMPOUNDS
chemical behavior of labeled, in iridium-192 recoil reactions with sodium iridium chloride, 18: 33662

IRIDIUM ISOTOPES
oxygen-16 reactions at 75 to 165 Mev, recoil studies for, 18: 34782 (UCRL-11563)

IRIDIUM ISOTOPES Ir-192
incorporation in compounds by recoil ion reactions on sodium iridium chloride, 18: 33662

IRON
beta scattering by, measurement of saturation backscattering from, 18: 35057
cavitation by liquid sodium, 18: 34075 (NASA-CR-54071)
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
content in Urey-Craig meteorites, 18: 34397
contents in meteorites, 18: 34398
cosmic shower production in, 18: 34474(T) (NASA-TT-F-126(p.286-91))
determination in MSRE fuel salts, 18: 34050(R) (ORNL-3626(p.59-164))
determination in mixture with uranium using potassium dichromate, titrimetric, 18: 33496
determination in refractory metals, review of methods for, 18: 33516
determination in silicon, activation, 18: 33502
determination of traces of, in water by atomic absorption spectrometry, 18: 33461 (DP-879)
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
effects on radiation damage in silicon crystals, 18: 34228
effects on sintering rates of tungsten, 18: 34098
effects on uranium production by electrorefining, phenomenon of, 18: 34093
electron scattering by, energy loss mechanisms in relativistic, 18: 34258(R) (AD-417250)
gamma backscattering from slabs of, 18: 35054
gamma transmission through slabs of, 18: 35051
gamma transmission through cylinders and spheres of, Monte Carlo calculations for, 18: 35052
heat transfer across contacting surface with aluminum, 18: 33735 (MIT-2079-2)
intestinal absorption of, double tracer technique for measuring, 18: 33440
iron-57 NMR in, fast-passage effects in, 18: 33583
neutron inelastic scattering at 2 to 5 Mev, 18: 34740
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
radiation effects on annealing in malleable cast, 18: 34229
reactions with plutonium nitride, 18: 34032(R) (BMI-1668(Del.))
separation from cerium-TTA solutions by solvent extraction using cupferron–chloroform, 18: 33540
separation from thorium and uranium by paper chromatography, 18: 33505
separation from zirconium by ion exchange on pyrocatechol-*O*,*O*-diacetic acid, 18: 33508
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
stored energy release in deformed Ferrovac E and Puron, 18: 34122(R) (GA-4900)
tensile properties of, effects of interaction of interstitial solute and substructure on, 18: 34204

IRON ALLOYS
properties as fuel element cladding in steam and water environments, 18: 34076 (TID-8540(p.213-330))
Ce–Fe, magnetic properties of Laves phase $CeFe_2$, 18: 34156
Cr–Fe, phase studies based on thermochemical data, 18: 33603
Fe–Mo–Nb, electric conductivity at 1.5 to 77°K, 18: 34183
Fe–Mo–Re, electric conductivity at 1.5 to 77°K, 18: 34183
Fe–Ni, composition dependence of spin wave energies in, 18: 34187
Fe–Zr, embrittlement effects of hydrogen on, 18: 34169

IRON CYANIDES
complexes with dipyridine, electron transfer in cerium oxidation of,

18: 33550
oxidation by cerium, iridium chloride, and molybdenum, electron-transfer reactions in, 18: 33550
oxidation of tungsten cyanide complexes by, electron-transfer reactions in, 18: 33550
IRON(III) HYDROXIDES
ion exchange properties for radioruthenium in sea water, 18: 33449(R) (NIRS-2(p.15-19))
IRON ISOTOPES Fe-54
neutron reactions (n,p) with, cross section of, 18: 34885
IRON ISOTOPES Fe-56
energy levels of, parameters for, 18: 34840
proton reactions (p,α) at 11 to 12.5 Mev, 18: 34855
proton reactions (p,n) at 7 to 13 Mev, 18: 34859
proton reactions (p,d) at 28 Mev, distorted-wave approximation for, 18: 34774 (ORNL-P-144)
proton reactions (p,γ) with, cobalt-57 decay scheme from, 18: 34792
IRON ISOTOPES Fe-57
gamma resonant scattering by, diffraction in, 18: 34929
nuclear magnetic resonance in iron, fast-passage effects in, 18: 33583
IRON ISOTOPES Fe-59
determination of physico-chemical state in liquid media by paper electrophoresis and radioactivity recording, 18: 33590
diagnostic use of, calibration methods for, 18: 34274(R) (NIRS-2 (p.3-15))
IRON OXIDES
MnZn(Fe_2O_4)$_x$, neutron total cross section at 11.5 Å, 18: 34752(R) (CU(PNPL)-234)
IRON(III) OXIDES
kryptonation of powders of, 18: 33450(R) (NYO-2757-4)
IRON SYSTEMS
C–Fe–Mo–Ni, corrosion of HyMu-80 in fluoride volatility process, 18: 34034(R) (BMI-1672(Del.))
Fe–Si, dislocation mobility in crystals of, 18: 34122(R) (GA-4900)
IRRADIATION FACILITIES
design of enclosure for swimming pool reactors, 18: 35230(P)
shielding for ducts in, 18: 35049
ISOCYANIC ACID
radioinduced polymerization of menthol ester of vinyl-, mechanism of, 18: 33674
ISOTOPE EFFECTS
biological, nuclear mass and, 18: 33258
on decarboxylation of oxalacetic acid, 18: 33598
on dipole moments of linear YXY' molecules, 18: 33597
ISOTOPE SEPARATION METHODS
development, 18: 34007(R) (ORNL-TM-890)
differential equation systems for flux and concentrations of mixture in plant stage, 18: 34004 (CEA-R-2337)
electromagnetic, development of, 18: 34005(R) (ORNL-TM-879)
thermal diffusion, development of, 18: 34005(R) (ORNL-TM-879)
thermal diffusion, development of, 18: 34006(R) (ORNL-TM-889)
thermal diffusion, column operations and development of, 18: 34007(R) (ORNL-TM-890)
ISOTOPES
separation factor in isotopic phase equilibria, 18: 34013
ISRAEL
activities of Chemistry Division of Soreq Research Establishment, 18: 33447 (IA-893)

J

JAPAN
cesium-137 and strontium-90 uptake by vegetables in, 18: 33805(R) (NIRS-2(p.57-67))
fallout monitoring, 1963, 18: 33263
JOINTS
design for two tubular elements, 18: 33708(P)
thermal stress analysis of zirconium–carbon steel scarf tube joint, 18: 33694 (HW-76850)
JOURNAL BEARINGS
design and performance analysis of liquid-metal-lubricated, 18: 33697(R) (SWRI-1228-26)

K

KIDNEYS
iodine-131 uptake by, in animals and chickens, 18: 33251
potassium-42 uptake by human, factors affecting, 18: 33238
radiation dose from cobalt-57-labeled EDTA to, 18: 33231(R) (NIRS-2(p.49-56))
radiation effects on formation of lipid oxidation products in homogenates of rat, 18: 33305
radiation effects on sorption in mouse, fission-product, 18: 33358
radiation effects on, from Thorotrast deposits, 18: 33426
radioinduced nephritis of, x, 18: 33288
radioinduced nephritis in human, 18: 33332
scintillation scans of, precautions for diagnosing, 18: 33433
KILNS
development of pot and spray calciners for processing wastes, 18: 35234(R) (HW-81862)
KRYPTON
content in Renazzo chondrite, 18: 34390
crystal stability of, three-body interactions in, 18: 34706
ionization of, appearance potential measurements on secondary ions produced by, 18: 33569
rare-gas-ion scattering at 80 kev by, energy losses from, 18: 34416
reactions with inert-gas atoms, van der Waals forces for, 18: 34345
separation from xenon, comparison of helium and nitrogen as carrier gas in chromatographic, 18: 35246(R) (MLM-1196)
KRYPTON ISOTOPES
separation by thermal diffusion, 18: 35246(R) (MLM-1196)
KRYPTON ISOTOPES Kr-80
energy levels of, lifetime of 620-kev, 18: 34845
KRYPTON ISOTOPES Kr-81
half life, 18: 34881
KRYPTON ISOTOPES Kr-82
energy levels of, lifetime of, 18: 34845
KRYPTON ISOTOPES Kr-85
development as universal tracer, 18: 33450(R) (NYO-2757-4)
diffusion in tantalum at high temperatures, 18: 34040(R) (GEMP-36A)
release from stressed Nichrome wire, 18: 33450(R) (NYP-2757-4)
sorption by various materials, 18: 33450(R) (NYO-2757-4)
use as bremsstrahlung sources, 18: 34287(T) (NP-tr-1160)
KRYPTON ISOTOPES Kr-86
separation by thermal diffusion, 18: 34005(R) (ORNL-TM-879)
KRYPTON SYSTEMS
Kr–methane, ionization appearance potential measurements on secondary ions produced by, 18: 33569

L

LABORATORIES
shielding materials for low-activity, 18: 35050
LABORATORY EQUIPMENT
sample changer design, automatic, 18: 33716
LAMINATES
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
radiation effects on, handbook on, 18: 34245
radiation effects on structural, at low temperatures, 18: 34247
LANTHANUM
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
gamma reactions (γ,n) with, neutron angular distribution from, 18: 34935
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
separation from thorium and uranium by paper chromatography, 18: 33505
separation from zirconium by ion exchange on pyrocatechol-*O,O*-diacetic acid, 18: 33508
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
LANTHANUM ALLOYS
Be–La, dissociation at high temperatures, 18: 34154
Cd–La, thermodynamic properties, 18: 33678(R) (ANL-6875)
La–Y, properties and structure of, 18: 34160
LANTHANUM FLUORIDES
erbium-ion spectra in, coherent emission and energy levels in absorption, 18: 33562
LANTHANUM IONS
binding to bovine serum albumin-stabilized emulsions, 18: 33575
LANTHANUM ISOTOPES La-139
yield in EBR-I Mark III fuel, 18: 35060(R) (ANL-6904)
LANTHANUM OXIDES
La_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
La_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
LAVA
deuterium content of biotite and hornblende phenocrysts from rhyolitic, 18: 33788

LEAD
beta scattering by, measurement of saturated backscattering from, 18: 35057
content in Panamint Range zircons, 18: 33793
contents in meteorites, 18: 34398
cosmic shower production in, 18: 34474(T) (NASA-TT-F-126(p.286-91))
determination in ores and concentrates by gamma absorption, 18: 33468(T) (AEC-tr-6399(p.61-71))
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
electron reactions (e,n) at 16 Mev, neutron spectra of, 18: 34945
gamma coherent scattering at small angles, 18: 35053
gamma transmission through cylinders and spheres of, Monte Carlo calculations for, 18: 35052
gamma transmission through slabs of, 18: 35051
infrared radiation absorption in superconducting, collective excitations in, 18: 34720
interfaces with molten fluoride salts, phenomena at, 18: 34050(R) (ORNL-3626(p.59-164))
ionization by electron and positron impact, 18: 34431
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
superconductivity of, effects of impurities on, 18: 34693
superconductivity of, microwave study of tunneling in, 18: 34696
x-ray L-emission spectrum, 18: 34410
x-ray scattering on, secondary electron emission from, 18: 34274(R) (NIRS-2(p.3-15))
LEAD ALLOYS
superconductivity of binary and isoelectronic, 18: 34693
Bi–Pb, superconductivity of, surface effects on, 18: 34683(R) (NP-14136)
In–Pb, superconductivity of, surface effects on, 18: 34683(R) (NP-14136)
Pb–Sn, beta scattering from, 18: 35057
Pb–Tl, superconductivity of, surface effects on, 18: 34683(R) (NP-14136)
LEAD CHLORIDES
Cl–$PbCl_2$, solvent properties for clad fuel elements, effects of copper on, 18: 33691(P)
LEAD GLASS
gamma attenuation at 0.1 to 10 Mev, coefficients for, 18: 35058
LEAD IONS
binding to bovine serum albumin-stabilized emulsions, 18: 33575
production using laser light, 18: 34297
LEAD ISOTOPES
evolution in earth, 18: 33792
origin of volcanic, 18: 33791
LEAD ISOTOPES Pb-202
preparation of carrier-free, for beta spectroscopy, 18: 33664
LEAD ISOTOPES Pb-203
preparation of carrier-free, for beta spectroscopy, 18: 33664
LEAD ISOTOPES Pb-204
energy levels, 18: 35246(R) (MLM-1196)
LEAD ISOTOPES Pb-206
age measurements in ratio with uranium-238 in uranium ores on Colorado Plateau, 18: 33796
deuteron reactions (d,p) with, in unified model, 18: 34871
energy levels, 18: 34906
helium ion fission of, fragments in, 18: 34880
LEAD ISOTOPES Pb-207
age measurements in ratio with uranium-235 in uranium ores on Colorado Plateau, 18: 33796
energy levels of, unified-model, 18: 34871
energy levels of, lifetime of first excited, 18: 34752(R) (CU(PNPL)-234)
LEAD ISOTOPES Pb-208
energy levels of, particle-hole description of, 18: 34889
neutron inelastic scattering by, analysis of, 18: 34910
nuclear structure of, alpha cluster reduced widths for, 18: 34891
oxygen-16 reactions at 75 to 165 Mev, recoil studies for, 18: 34782 (UCRL-11563)
LEAD ISOTOPES Pb-210
content in fumarole sublimator from Mount Vesuvius, 18: 33791
LEAD ISOTOPES Pb-212
electron conversion spectra, 18: 34786
LEAD ISOTOPES Pb-214
content in air near ground, beta counting method for determining, 18: 34257
electron conversion spectra, 18: 34786
LEAD MOLYBDATES
$Bi_2(MoO_4)_3$–$PbMoO_4$, phase diagram, 18: 34195
LEAD OXIDES
radiation effects on crystal structure of, fast neutron, 18: 34241
LEAD POISONING
effects of EDTA on, in rats, 18: 33249
LEAKS
detection and measurement, 18: 35207
rate detection in reactor containers, evaluation of errors in, 18: 33757
LEAVES
radiation effects on extracts of cellular structures of sugar beet, by seed exposure, 18: 33314
LECTURES
book: *Phonons and Phonon Interactions*, 18: 34451
on the impact of quantum mechanics on physical metallurgy, 18: 34066
LEPTONS
mass spectrum of, 18: 34603
theory of heavy charged, 18: 34615
LEUKEMIA
effects on leucocyte enolase activity, 18: 33231(R) (NIRS-2(p.49-56))
radiation effects on human, *in utero* exposure, 18: 33391
radioinduced by chronic occupational exposure, 18: 33347
radioinduced in mice, x, 18: 33311
trace element content of leukocytes in, neutron activation analysis of, 18: 33517
LEUKOCYTES
enolase activity in leukemic and normal human, 18: 33231(R) (NIRS-2(p.49-56))
radiation effects on phagocytic activity of neutrophils in rabbits, tracer study of, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on guinea pig, 18: 33363
storage of viable, in frozen state, 18: 33215(R) (TID-20824)
trace element content of normal and leukemic, neutron activation analysis of, 18: 33517
LEVEL INDICATORS
description of follow-up radiometric, with stationary radiation source, 18: 33849(T) (AEC-tr-6399(p.153-62))
design and testing of ultrasonic, 18: 33832(R) (NYO-10560)
design for liquid sodium, 18: 33827 (EUR-1823.d)
design of radiometric, 18: 34000
design of ultrasonic, for molten metals and salts, 18: 33830(R) (NYO-10556)
radiometric, use of scintillation detectors with light ducts in, 18: 33850(T) (AEC-tr-6399(p.163-72))
LIGHT
amplification of, equipment for, 18: 33906
distribution in auroras, 18: 34672
gas breakdown by intense pulses of, 18: 34350
interaction of laser beams with atomic electrons, 18: 34458
polarization of, from helium, 18: 34445
scattering by theta-pinch plasma, spectral distributions of, 18: 35010
velocity of, source velocity independence of, 18: 34294
LIGNITES
sorptive properties for chromium and cobalt from solutions, 18: 35235 (IDO-12036)
LINEAR ACCELERATORS
design for Cambridge Synchrotron, 18: 34367 (CEAL-1000)
operation, 18: 34271(R) (LAL-1107)
LIPIDS
metabolism in sheep, tracer studies, 18: 33213 (STI/DOC/10/28(p.79-103))
radiation effects on formation of oxidation products of, in rat intestine, kidneys, and liver homogenates, 18: 33305
radiation effects on composition of rat liver, gamma, 18: 33360
radiation effects on synthesis of, in rat spleen, 18: 33382
LIQUID METAL COOLED REACTORS
coolant circulation in multicircuit, transient regimes of natural, 18: 35081
core design for, 18: 35105(P)
design of settled-bed, 18: 35124(P)
design with auxiliary cooling means, 18: 35122(P)
excursions in fast ceramic, 18: 35146(R) (GEAP-4601)
fuel plate assembly design for, 18: 35132(P)
fuels for fast power, development and testing of ceramic, 18: 35146(R) (GEAP-4601)
kinetics of fast ceramic, 18: 35146(R) (GEAP-4601)
power production in fast breeder, MHD impact flow tube for, 18: 35166(T) (ANL-Trans-38)
review and survey of commercial power, using sodium, 18: 35161 (TID-8540(p.71-129))
steam generator development for sodium-cooled, 18: 33741(R) (TID-20603)

LIQUIDS
analysis by beta absorption, instrument for, 18: 33473(T) (AEC-tr-6399 (p.115-23))
molecular friction constant in, use of isotope separation data for calculation of, 18: 34308
perturbation expansion for Bose, at zero temperature, 18: 34686
viscosity at high pressure and temperature, device for measuring, 18: 33858
LITHIUM
determination by neutron activation, 18: 33678(R) (ANL-6875)
effects on biaxial creep of type 304L stainless steel, 18: 34030 (APL-TDR-64-73)
effects on prismatic slip in magnesium, 18: 34134 (UCRL-11417)
electron scattering by, excitation cross sections for, 18: 34429
meson (π) scattering at 80 Mev, high-energy approximation, 18: 34911
nuclear magnetic shielding in, theory of, 18: 33563
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
properties as reactor working fluid, 18: 35198 (NAA-SR-8617(Vol.I))
LITHIUM ALLOYS
Bi–Li, thermodynamic properties at 775 to 1150°K, 18: 33678(R) (ANL-6875)
Ca–Li, phase diagram, 18: 34131 (TID-20849)
Li–Sn, thermodynamic properties, 18: 33678(R) (ANL-6875)
LITHIUM BROMIDES
LiBr–LiH, phase studies and thermodynamic properties, 18: 33678(R) (ANL-6875)
LITHIUM CHLORIDES
LiCl–KCl, spectra of lithium telluride at 500°C in, absorption, 18: 35060(R) (ANL-6904)
LiCl–$MgCl_2$–NaCl, liquidus lines at 450 to 600°C, 18: 35060(R) (ANL-6904)
LITHIUM FLUORIDES
crystal structure of, acoustic attenuation study of friction on fast moving dislocations in, 18: 34276 (NP-14129)
lubricating properties of fused coatings of, in air, hydrogen, liquid sodium, and vacuum, 18: 33695 (NASA-TN-D-2348)
nuclear magnetic shielding in, theory of, 18: 33563
radiation effects on absorption spectra, electron emission, and luminescence of, alpha and x, 18: 33632
radiation effects on solid, electron, 18: 34050(R) (ORNL-3626(p.59-164))
radioinduced dislocations in, motion of, 18: 34276 (NP-14129)
BeF–LiF, interface phenomena with liquid lead, 18: 34050(R) (ORNL-3626(p.59-164))
BeF_2–LiF, purification by removal of sulfates, 18: 34050(R) (ORNL-3626(p.59-164))
BeF_2–LiF–ThF_4–UF_4–ZrF_4, radiation effects on, 18: 34050(R) (ORNL-3626(p.59-164))
BeF_2–LiF–ZrF_4, crystallographic and phase studies on, 18: 34050(R) (ORNL-3626(p.59-164))
CaF_2–LiF, lubricating properties of fused coatings of, in air, hydrogen, liquid sodium, and vacuum, 18: 33695 (NASA-TN-D-2348)
LiF–NaF–ZrF_4, corrosive effects on HyMu-80 and INOR-8 under hydrofluorination conditions, 18: 34034(R) (BMI-1672(Del.))
LITHIUM HYDRIDES
electric field gradients of, 18: 34444
electrolysis of solid, isotope effects in, 18: 33536
nuclear magnetic shielding in, theory of, 18: 33563
thermodynamic properties, 18: 35060(R) (ANL-6904)
wave functions for, properties of, 18: 34444
LiBr–LiH, phase studies and thermodynamic properties, 18: 33678(R) (ANL-6875)
LiH–NaCl, phase diagram, 18: 35060(R) (ANL-6904)
LITHIUM HYDROXIDES
electrolysis of aqueous solutions of, separation of lithium isotopes by, 18: 34009
LITHIUM IODIDES
scintillation processes in crystals of, 18: 33636
LITHIUM IONS
ionization of Li^+, by electron impact, research program on, 18: 34406(R) (TID-20877)
reactions of, knock-out and two-nucleon stripping, 18: 34856
LITHIUM ISOTOPES
separation in aqueous lithium hydroxides, electrolytic, 18: 34009
LITHIUM ISOTOPES Li-6
electron reactions at 1 and 4 Bev, proton production in, 18: 34916
emission in oxygen-16 reactions with nuclei at 167 Mev, spectra of, 18: 34780 (UCRL-11349)
energy levels, 18: 34867
enrichment in lithium sulfate electrolysis on zinc cathode, 18: 33596
lithium-6 reactions (Li-6, 3α) at 2 Mev, 18: 34819
neutron reactions with, 18: 34799
nuclear structure of, alpha-deuteron cluster wave functions for, 18: 34631
reaction (Li-6, 3α) with lithium-6 at 2 Mev, 18: 34819
LITHIUM ISOTOPES Li-7
deuteron reactions (d,n) with, gamma emission in, 18: 34806
emission in oxygen-16 reactions with nuclei at 167 Mev, spectra of, 18: 34780 (UCRL-11349)
enrichment in electrolysis of solid lithium hydride, 18: 33536
enrichment in lithium sulfate electrolysis on zinc cathode, 18: 33596
magnetic relaxation in aqueous solutions of paramagnetic salts, 18: 33601
proton reactions (p,γ) at 800 to 1700 kev, 18: 34875
LITHIUM ISOTOPES Li-8
emission in oxygen-16 reactions with nuclei at 167 Mev, spectra of, 18: 34780 (UCRL-11349)
production in proton reactions with emulsion nuclei at 2 to 9 Bev, 18: 34940
LITHIUM SULFATES
electrolysis on zinc cathode, isotope effects and reactions in, 18: 33596
LITHIUM TELLURIDES
spectra in cesium chloride at 700°C, absorption, 18: 35060(R) (ANL-6904)
spectra in lithium chloride–potassium chloride at 500°C, absorption, 18: 35060(R) (ANL-6904)
LIVER
analysis of, for phospholipids, in fatty, from rats, 18: 33493
cerium-144 uptake by rat, 18: 33252
iodine-131 uptake by, in animals and chickens, 18: 33251
radiation effects on nucleic acid synthesis in, effects of partial-hepatectomy in rats, 18: 33294
radiation effects on potassium levels in regenerating rat, x, 18: 33301
radiation effects on formation of lipid oxidation products in homogenates of rat, 18: 33305
radiation effects on cell nuclei in mouse, x, 18: 33350
radiation effects on lipid composition in rat, gamma, 18: 33360
radiation effects on rat, 18: 33380
radium-228 biological half life in, 18: 34274(R) (NIRS-2(p.3-15))
LIVER DISEASES
diagnosis of, use of tracer methods for, 18: 33214 (STI/DOC/10-28 (p.105-11))
LUBRICANTS
evaluation for use in uranium fabrication processes, 18: 34085(R) (BRB-81)
properties of fused fluoride coatings as, in air, hydrogen, liquid sodium, and vacuum, 18: 33695 (NASA-TN-D-2348)
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
LUMINESCENT DETECTORS
design of thermo-, 18: 33981(P)
LUNG DISEASES
radiotherapy of pleural effusion, gold-198, 18: 33439
LUNGS
radioactive particle retention in, estimation of, from fecal analysis, 18: 33266
retention of inhaled plutonium-239 by, 18: 33260
uranium absorption from, 18: 33268
LUTETIUM
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
LUTETIUM ISOTOPES Lu-178
beta decay of, coincidence measurements and spectra for, 18: 34843
LYMPH CELLS
formation of, from injected bone marrow in irradiated dogs, 18: 33337
radiation effects on liberation of polydesoxyribonucleotides from, 18: 33308
LYMPH SYSTEM
radiation effects on, specificity of, 18: 33272(R) (NIRS-2(p.31-42))
LYSINES
radiation sickness effects on metabolism of, in calcified tissues in rats, 18: 33346
LYSOZYME
radiation effects on amino acid content and inactivation of, ultraviolet, 18: 33295

M

MACHINING
of refractory metals, problems in, 18: 34106
MAGNESIUM
alpha elastic scattering at 24.7 Mev, relative cross sections for,

18: 34902
contents in meteorites, 18: 34398
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
prismatic slip in single crystals of, effects of lithium on, 18: 34134 (UCRL-11417)
production by vacuum distillation, 18: 34051 (ORNL-TM-749)
separation from thorium and uranium by paper chromatography, 18: 33505
separation from zirconium by ion exchange on pyrocatechol-*O,O*-diacetic acid, 18: 33508
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
welding of, characteristics of electron beam, 18: 34112

MAGNESIUM ALLOYS
analysis for zirconium, photometric, 18: 33512
Al–Mg, decomposition reactions of solid solutions of, effects of vacancies on, 18: 34135(T) (Al-Trans-53)
Al–Mg, radiation effects on aging and resistivity of, 18: 34244
Cd–Mg–Zn, solubility of praseodymium and uranium in, 18: 33678(R) (ANL-6875)
Mg–Nd, effects of plastic deformation on properties and structure of, 18: 34148
Mg–Zr, fine-grained structure in magnesium extruded, 18: 34182

MAGNESIUM CHLORIDES
radiosensitivity effect on barley seeds, 18: 33409
LiCl–$MgCl_2$–NaCl, liquidus lines at 450 to 600°C, 18: 35060(R) (ANL-6904)

MAGNESIUM IONS
production using laser light, 18: 34297

MAGNESIUM ISOTOPES
separation in calutrons, 18: 34005(R) (ORNL-TM-879)
separation in calutrons, 18: 34007(R) (ORNL-TM-890)
separation of stable, in calutrons, 18: 34005(R) (ORNL-TM-879)

MAGNESIUM ISOTOPES Mg-24
alpha reactions (α,d) at 45 to 50 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
nuclear structure calculations for, 18: 34781 (UCRL-11376)

MAGNESIUM ISOTOPES Mg-25
proton inelastic scattering parameters of, 18: 34752(R) (CU(PNPL)-234)
proton reactions (p,α) at 9 Mev, 18: 34821

MAGNESIUM ISOTOPES Mg-26
proton inelastic scattering parameters of, 18: 34752(R) (CU(PNPL)-234)

MAGNESIUM OXIDES
effects on properties and sintembility of zirconium oxide, 18: 34155
plastic deformation at 1000 to 1600°C of single crystals of, stress-strain measurements, 18: 34132 (UCRL-11323)
plastic flow initiation in single crystals of, effects of dislocation configurations on, 18: 34123 (HR-64-269)
positron annihilation in, angular correlations from, 18: 33605

MAGNESIUM SULFATES
protective effects against radiation effects on amino acid content in wheat sprouts, 18: 33398
reduction by hydrogen, 18: 33529 (ORNL-3334(Pt.II))

MAGNET COILS
field energy removal from superconducting, methods for, 18: 34690
insulation for, development of, 18: 33717

MAGNETIC FIELDS
action integral for charged particles trapped in, invariance of, 18: 34293
analysis of, computer programs for, 18: 34266 (CLM-R-31)
calculation for right-circular conical current sheets using Legendre polynomials, 18: 34273 (NASA-TN-D-2400)
detonation wave propagation in conducting fluids in, 18: 34329
diffusion in shock wave interactions with electromagnetic fields, 18: 34333
effects on superconductor electrodynamics, nonlinear, 18: 34721
effects on thin superconducting films, 18: 34682(R) (NBS-8407)
fluid flow in transverse, hydromagnetic stability of Couette, 18: 34317
fluid flow in transverse, heat transfer in, 18: 34359
fluid flow in, magnetic energy production and dissipation in, 18: 34327
fluid flow past insulated plate in, viscous conducting, 18: 34316
flux conservation by superconducting thin film rings, 18: 34698
flux transport by shock-produced plasma, 18: 35007
focusing properties of sextupole, for neutral particles, 18: 34369 (JINR-P-1681)
gas flow in, theory of, 18: 35035
magnetohydrodynamic flow in uniform, stagnation-point, 18: 34319
magnetohydrodynamic shock in interplanetary, 18: 34393
plasma flow over conducting surfaces in, boundary conditions for, 18: 35005
plasma jet configuration and particle losses in curved, 18: 35023
plasma kinetics in, book on, 18: 35028
plasma motion across, heat transfer in nonisothermal, 18: 35026
plasma motion in strong, 18: 35027
plasma transport equations for, 18: 35018

MAGNETIC MATERIALS
development and testing for space power systems, 18: 34036(R) (NASA-CR-54041)
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))

MAGNETIC MIRROR MACHINES
electron cyclotron resonance instability in, 18: 35008
plasma jet configuration and particle losses in curved fields of, 18: 35023
plasma stability in, analysis of, 18: 34979 (UCRL-11077)

MAGNETIC MIRRORS
plasma behavior in, computer programs for analysis of, 18: 34266 (CLM-R-31)

MAGNETIC MONOPOLES
signs of, 18: 34291

MAGNETIC RECORDING SYSTEMS
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))

MAGNETIC RESONANCE
book: *Electron Spin Resonance in Biology*, 18: 33227
in biological systems, 18: 33283(R) (TID-20889)
measurement of *para*-, noise effects in, 18: 33855

MAGNETITES
magnetic susceptibility of grout mixtures of, effects of explosive shock on, 18: 34284 (UCRL-13088)
oxygen isotope fractionation between quartz, calcite and, for geothermometry, 18: 33785

MAGNETOHYDRODYNAMIC CELLS
development for space power systems, status of, 18: 34001
development of, review of, 18: 34499
nozzle pumping characteristics, 18: 35060(R) (ANL-6904)
performance, 18: 34501
performance of chemically fueled, 18: 34296
testing of ion engines, techniques for flight-simulation, 18: 34261 (AEDC-TDR-64-127)

MAGNETOHYDRODYNAMICS
book: *Magnetohydrodynamic Shock Waves*, 18: 34360
book: *Problems in Magnetogasdynamics*, 18: 35028
conducting incompressible flow at low Reynolds numbers, 18: 34359
equations for plane-symmetrical fields in, exact solutions of, 18: 34295
flow of conducting fluid in alternating magnetic field, conductivity distribution in, 18: 34358
fluid flow in transverse magnetic fields in, stability of Couette, 18: 34317
fluid flow in, magnetic energy production and dissipation in, 18: 34327
fluid flow in, stagnation-point, 18: 34319
fluid flow in, survey on, 18: 34264 (ARL-63-175(Pt.II))
fluid flow past insulated flat plate in, viscous conducting, 18: 34316
fluid flow stability in channels in aligned fields, 18: 34267 (D1-82-0331)
gas flow in, theory of, 18: 35035
gas flow in, theory of two-dimensional, 18: 34321
gas flow past blunt or nonblunt body in hypersonic, 18: 34272 (NASA-CR-88)
hydromagnetic wave propagation by oscillating conducting boundary, 18: 34328
plasma flow over conducting surfaces, boundary conditions for, 18: 35005
plasma kinetics in, MGD equations for, 18: 35034
plasma pinch discharges in, similarity solutions for transient, 18: 34997
shock propagation in plasma, 18: 35006
stability in, variational properties of, 18: 34326
stability of inviscid vortex flow with finite conductivity, 18: 34363
use for power production in fast breeder reactors, 18: 35166(T) (ANL-Trans-38)

MAGNETOMETERS
design of nuclear-induction, for weak fields, 18: 33870(P)
development for high fields at low temperatures, 18: 33865

MAGNETOSPHERE
electron intensity beyond boundary of, with energies >30 kev, 18: 34680
plasma trapping in, simulated, 18: 34984

MAGNETS
design for Cambridge synchrotron, 18: 34367 (CEAL-1000)
design for synchrocyclotrons, analytic method for, 18: 34376
development of cryogenic, 18: 34682(R) (NBS-8407)
development of superconducting, 18: 34715
insulation for pulsed-coil, development of, 18: 33717

MAGNOX ALLOYS
chemical composition and properties of, for use as reactor materials, 18: 34176
MAIZE
radiation effects on hydroponically-grown, gamma, 18: 33997
radioinduced mutations of, yield from, 18: 33279(R) (TID-20823)
MALIBU POWER REACTOR
fuel scheduling for, using IBM 1620, 18: 35187
MALONIC ACID, DIETHYL ESTER
analysis for active hydrogen by NMR spectroscopy, 18: 33475
MAN
analysis for cesium-134 content, by whole-body counting or analysis of urine, 18: 33265
analysis for cesium-137 content, by whole-body counting or analysis of urine, 18: 33265
analysis for potassium-40 by whole-body counting, *in vivo* determination of lean body mass from, 18: 33487
analysis for thorium-232, by whole-body counting, 18: 33269
bone marrow regeneration in, 18: 33216
calcium metabolism in, tracer studies of, 18: 33277 (STI/DOC/10/28 (p.21-38))
cesium-137 content of urine in, 18: 33805(R) (NIRS-2(p.57-67))
chromosomal diseases in, role of heredity and radiation exposure in, 18: 33336
determination of radium deposits in, by analysis of breath for radon, 18: 33262
effects of age on bone composition in, 18: 33276(R) (NYO-910-7)
monitoring for alpha sources, 18: 33819
percutaneous absorption in, clinical significance of, 18: 33224
plutonium metabolism in, mathematical models for, 18: 33267
potassium-42 distribution in, factors affecting, 18: 33238
radiation effects on electrophoretic distribution of blood serum proteins, 18: 33353
radiation hazards to, computer analyses of space-flight, 18: 35048 (AMRL-TDR-64-11)
radiation sickness in, protective effects of bone marrow hemopoietic cell transplantations against, 18: 33403
radiodermatitis in, effects on trace element content of blood, 18: 33285(T) (JPRS-25502)
radioinduced atherosclerosis in, 18: 33277 (STI/DOC/10/28(p.21-38))
radioinduced nephritis in, 18: 33332
radium-226 body burden of, method for determining, 18: 33821
retention of inhaled plutonium-239 by, 18: 33260
trace elements in heart of, neutron-activation determination of, 18: 33457 (AE-146)
treatment of thrombocytopenia in, with stored platelets, 18: 33215(R) (TID-20824)
urinary excretion rates of radionuclides for, 18: 33518
MANGANESE
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
content in normal and leukemic leukocytes, activation analysis of, 18: 33517
contents in meteorites, 18: 34398
determination in mixture with uranium using potassium dichromate, titrimetric, 18: 33496
determination in silicon, activation, 18: 33502
determination of traces of, in water by atomic absorption spectrometry, 18: 33461 (DP-879)
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
gamma attenuation at 0.1 to 10 Mev, coefficients for, 18: 35058
gamma reactions (γ,n) with, neutron angular distribution from, 18: 34935
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
MANGANESE ALLOYS
Cu–Mn, crystal structure of, acoustic attenuation study of friction on fast moving dislocations in, 18: 34276 (NP-14129)
Gd–Mn, structure of $GdMn_2$, 18: 34026 (AD-428771)
Mn–Hg–Sm, preparation of amalgams of, 18: 34027 (AD-428772)
Mn–Hg–Y, preparation of amalgams of, 18: 34026 (AD-428771)
Mn–Hg–Y, preparation of amalgams of, 18: 34027 (AD-428772)
Mn–rare earth, preparation of amalgams for studies of, 18: 34028 (AD-430037)
Mn–Sm, amalgam studies, 18: 34026 (AD-428771)
Mn–Ti, magnetic moments and superconductivity of, 18: 34700
Mn–Ti–Zr, magnetic moments and superconductivity of, 18: 34700
Mn–Y, structure of YMn_2 and YMn_4, 18: 34026 (AD-428771)
Mn–Y, structure of Laves phase YMn_2, 18: 34027 (AD-428772)
MANGANESE CARBONYLS
$(CO)_5Mn–Re(CO)_5$, spectra of, infrared, 18: 33551
MANGANESE IONS
electron spin resonance in zeolites, 18: 34268 (IFA-IS-27)
MANGANESE ISOTOPES Mn-51
energy levels, 18: 34793
MANGANESE ISOTOPES Mn-53
energy levels, 18: 34855
energy levels, 18: 34797
MANGANESE ISOTOPES Mn-54
gamma spectra of, least-squares analysis of, 18: 33926
half life, 18: 34885
MANGANESE ISOTOPES Mn-55
proton reactions (p,α) at 11 to 12.5 Mev, 18: 34855
MANGANESE ISOTOPES Mn-56
beta decay of, gamma spectra for, 18: 34840
MANGANESE OXIDES
$MnZn(Fe,O_4)_2$, neutron total cross section at 11.5 Å, 18: 34752(R) (CU(PNPL)-234)
neutron total cross section at 11.5 Å, 18: 34752(R) (CU(PNPL)-234)
MARCOULE REACTORS (G-2)
pressure vessel for, prestressed concrete, 18: 35196
MARCOULE REACTORS (G-3)
pressure vessel for, prestressed concrete, 18: 35196
MARITIME REACTORS
construction of, quality control and testing in, 18: 35206
design of boiling-water, 18: 35217(P)
development for U.S. Merchant Marine, 18: 35203 (NP-14139)
leak detection and measurement in, 18: 35207
safety, 18: 35209
use in surface-effect ships, 18: 35215
MASERS
infrared, plasma diagnostics with, 18: 35013
Stokes shift effects on operation of three-level, 18: 34280(R) (NYO-2680-1)
MASERS (OPTICAL)
beam interactions with atomic electrons, 18: 34458
beam reactions with foils, plasma production in, 18: 35039
beam scattering by plasma, 18: 34348
development for power generation, review of, 18: 34499
gas breakdown by light pulses from, 18: 34350
ion photoproduction with, 18: 34297
properties of europium benzoylacetonate, 18: 33561
spectra of chelate, ligand-field, 18: 33565
MASS SPECTROMETERS
use as effusiometer, 18: 33867
MATERIALS TESTING
compressed gas gun for transient stress, 18: 33756
equipment and methods for space electric power systems, 18: 34046(R) (NASA-CR-54041)
for nuclear-powered spacecraft, 18: 34247
nondestructive methods for reactor fuel elements, 18: 35060(R) (ANL-6904)
properties of ultrasonic, 18: 35208
radiation protection in, 18: 34223
MATERIALS TESTING REACTOR MOCKUP
coolant-loss testing during 1951, 52, and 53, 18: 35222 (ORNL-TM-632)
MATHEMATICS
bounds on generalized Fourier coefficients, 18: 34020
bounds on matrix elements of bounded operators, 18: 34021
cluster and product properties of sequences of symmetric functions, 18: 34313
eigenvalues of random real symmetric matrices, isolated, 18: 34023
Green functions, theory and applications of, 18: 34648
inversion of cyclic matrices, 18: 34019
Legendre polynomial evaluation of magnetic fields from conical current sheets, 18: 34273 (NASA-TN-D-2400)
matrices in, computer program for inversion of nonsingular square, 18: 34016 (JEN-122-DF/I-38)
models for plutonium metabolism in man, 18: 33267
plasma dynamics equations in, classical and quantum, 18: 34971 (ARL-64-85)
self-avoiding walks on integral points in Euclidean space, number of, 18: 34312
MATTER
distribution functions of charged particle systems in equilibrium, 18: 34415
MECHANICS
plasma dynamics in statistical, 18: 34971 (ARL-64-85)
two-body correlation functions for lattice gas statistical, integral equations for, 18: 34336

MEDICINE
image-retaining panel in dental, evaluation of, 18: 33443
MELAMINE, TRIETHYLENE-
aberrant effects on chromosomes, mechanism of, 18: 33271(R) (NIRS-2(p.26-31))
MEMBRANES
permeation of alumina, effects of stresses on, 18: 34056 (UCRL-11355)
radiation effects on water permeability of connective tissues in rats, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on formation of plant cell, 18: 33372
MERCAPTO GROUP
effects of lipidic peroxides on, in albumin, 18: 33236(T) (ANL-Trans-54)
effects on radiosensitivity of *Escherichia coli*, 18: 33275(R) (NYO-910-2)
protective effects of, against radiation injuries in embryos of rats and mice, 18: 33423
MERCHANT VESSELS
analysis of surface-effect, using nuclear power, 18: 35215
nuclear power in U.S. Merchant Marine, 18: 35203 (NP-14139)
nuclear propulsion systems for, 18: 35205
reactor safety in, 18: 35209
MERCURY
charge exchange with iodine ions near resonance, 18: 34448
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination in pure uranium compounds by solvent extraction using dithizone, 18: 33509
determination in silicon, activation, 18: 33502
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
gamma coherent scattering at small angles, 18: 35053
infrared radiation absorption in superconducting, collective excitations in, 18: 34720
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
properties as reactor working fluid, 18: 35198 (NAA-SR-8617(Vol.I))
MERCURY ALLOYS
formation of amalgam containing manganese and rare earth metal, 18: 34026 (AD-428771)
preparation of amalgams for studies of rare earth-manganese alloys, 18: 34028 (AD-430037)
Hg–Tl, compound formation in, 18: 34131 (TID-20849)
Mn–Hg–Sm, preparation of amalgams of, 18: 34027 (AD-428772)
Mn–Hg–Y, preparation of amalgams of, 18: 34026 (AD-428771)
Mn–Hg–Y, preparation of amalgams of, 18: 34027 (AD-428772)
MERCURY IONS
charge exchange in air, cross sections for, 18: 34409
MERCURY ISOTOPES Hg-193
electron conversion spectra, 18: 34786
MERCURY ISOTOPES Hg-195
electron conversion spectra, 18: 34786
MERCURY ISOTOPES Hg-196
energy levels of, measurement of lifetime of first excited, 18: 34772 (NP-14184)
MERCURY ISOTOPES Hg-203
distribution in uremic patients, effects on renal scans of, 18: 33433
MESIC ATOMS
deuteron reactions with deuterium, yields in, 18: 34617
meson (μ^-) exchange between hydrogen and carbon, 18: 34947
production in deuteron reactions with deuterium mesic atoms, 18: 34617
production of carbon, in meson (μ^-) exchange with protons, 18: 34947
x-ray emission from (μ), 2p-1s energies for, 18: 34435
MESONS
bootstrap calculations for vector, 18: 34557
exchange by nucleons in nuclei, 18: 34915
exchange of pseudoscalar, scalar, and vector, in nucleon interactions, 18: 34539
Feynman diagrams for pseudoscalar, majorization of, 18: 34521
interaction resonances of, review on, 18: 34636
interactions of pseudoscalar, with nucleons, fermion Regge trajectories for, 18: 34558
interactions of pseudoscalar, with baryons, 18: 34567
interactions of vector, with electromagnetic fields, 18: 34545
interactions of, SU_3 model for strong, 18: 34510 (NP-14146)
interactions with baryons, unitary symmetry in, 18: 34585
interactions with protons, SU(3) symmetry in, 18: 34586
mass spectrum of, 18: 34603
photoproduction of vector, on nucleons, 18: 34620
production in cosmic particle interactions in emulsions, 18: 34492
production of vector, in baryon-pseudoscalar meson interactions, 18: 34567
production of vector, in meson (π)-nucleon interactions, 18: 34620
resonance states of, in nucleon interactions, 18: 34539
resonances with baryons in W_3 symmetry, 18: 34553
resonances with baryons, 45-fold $\frac{1}{2}^+$ multiplet of, 18: 34554
resonances with baryons in SU(3) with reciprocal bootstrap, 18: 34556
theory of neutral vector, gauge-invariant, 18: 34606
MESONS (η)
exchange in nucleon interactions, potentials for, 18: 34539
interactions with mesons (π), 1-Bev resonance in, 18: 34572
resonance ($\pi^+\pi^-\eta$) at 959 Mev, properties of, 18: 34515 (UCRL-11431)
review, 18: 34636
MESONS (f)
production of, effects of nonresonant d-wave interaction on spin in, 18: 34630
MESONS (f^0)
contribution to meson (π)-nucleon scattering, 18: 34611
contribution to proton-proton scattering, 18: 34610
MESONS (K)
beam separator design for, crossed-field, 18: 34365 (BNL-8145)
interactions with mesons (π), 18: 34534
interactions with hyperons (Ξ), hyperon (Ω^-) production in, 18: 34568
interactions with mesons (K) resonance, 18: 34636
pair production in meson interactions (π-π), 18: 34534
MESONS (K^-)
interactions with protons at 2.45 and 2.7 Bev/c, $\Lambda\mu^+\mu^-$ and Λe^+e^- production in, 18: 34513 (UCRL-11428)
interactions with protons at 2.4 to 2.7 Bev/c, bubble chamber studies of final-state resonances in, 18: 34515 (UCRL-11430)
interactions with protons at 2.4 to 2.7 Bev/c, production of 959-Mev resonance in, 18: 34515 (UCRL-11431)
interactions with protons at 2.4 to 2.7 Bev/c, (Ξ-π) resonance (1530 Mev) spin and parity from, 18: 34517 (UCRL-11436)
MESONS (K^0)
decay of, CP violation in, 18: 34590
decay of, effects of selection rules and invariance on partial rates for, 18: 34506 (BNL-8094)
decay of, selection rules for nonleptonic, 18: 34628
decay of, 2π, 18: 34578
mass difference (K_1^0–K_2^0), 18: 34593
MESONS ($\bar{K}^0$)
interactions with nucleons, assuming Y_0^* Regge particle, 18: 34571
MESONS (K^+)
decay of, bubble chamber study of four-body leptonic, 18: 34519 (UCRL-11549)
decay of, effects of selection rules and invariance on partial rates for, 18: 34506 (BNL-8094)
decay of, 2π, 18: 34578
interactions with protons to 450 Mev, 18: 34543
photoproduction on protons, dispersion relations for, 18: 34536
MESONS (K_{e4})
decay of, bubble chamber study of, 18: 34519 (UCRL-11549)
MESONS (ω)
capture by nucleons, pseudoscalar coupling magnitude in, 18: 34551
pair photoproduction at small angles, asymmetric, 18: 34594
scattering in nuclear emulsions at 8 Bev, multiple, 18: 34627
MESONS (μ^-)
capture by helium-3 and -4 at 100 to 120 Mev/c, rates for, 18: 34776 (UCRL-11004)
effects on deuteron interactions, catalysis, 18: 34617
emission in deuteron reactions with deuterium mesic atoms, 18: 34617
exchange between hydrogen mesic atoms and carbon, 18: 34947
MESONS (ω)
exchange in nucleon interactions, potentials for, 18: 34539
mixing with meson (ϕ), angle for, 18: 34574
production in meson (K^-)-proton interactions, negative experimental results for, 18: 34513 (UCRL-11428)
review, 18: 34636
MESONS (ω^0)
decay of, angular distributions in, 18: 34622
production in meson (π)-nucleon interactions, amplitudes and Regge poles for, 18: 34622
MESONS (ϕ)
mixing with meson (ω), angle for, 18: 34574
production and decay of, study from meson (K^-)–proton interactions at 2.5 Bev/c, 18: 34514 (UCRL-11430)
production in meson (K^-)-proton interactions, negative experimental results for, 18: 34513 (UCRL-11428)
review, 18: 34636

MESONS (π)
charge correlation coefficients for n-body system of, 18: 34530
interactions with nucleons, relativistic corrections to s- and p-wave, 18: 34507 (JINR-E-1686)
interactions with nucleons, secondary-particle production in, 18: 34509 (NP-14086)
interactions with nucleons, complex singularities in amplitude for, 18: 34524
interactions with mesons (π), meson (K) pair production in, 18: 34534
interactions with mesons (K), 18: 34534
interactions with nucleons, maximum coupling constant for, 18: 34548
interactions with electrons, radiative corrections to, 18: 34563
interactions with mesons (η), 1-Bev resonance in, 18: 34572
interactions with mesons (π), modified N/D method for, 18: 34573
interactions with mesons (π), 18: 34579
interactions with mesons (ρ), resonance, 18: 34581
interactions with mesons (π), analysis of s-wave, 18: 34595
interactions with nucleons below 500 Mev, analysis of, 18: 34604
interactions with nucleons, meson (f^0) contribution to, 18: 34611
interactions with nucleons at low energies, phase shifts in, 18: 34621
interactions with nucleons, mesons (ω^0) and (ρ) production in, 18: 34622
production by primary cosmic nucleons in atmosphere, 18: 34485
production in proton–proton interactions at 2 Bev, 18: 34633
reactions in nuclear emulsion, radii for, 18: 34964
resonance (Ξ-π) at 1530 Mev, parity and spin of, 18: 34517 (UCRL-11436)
scattering by light nuclei, high-energy approximation, 18: 34911
statistics of, 18: 34628

MESONS (π^-)
capture by nuclei, nucleon correlations from, 18: 34851
interactions with protons at 310 Mev, neutron polarization and phase-shift analysis in, 18: 34512 (UCRL-11140)
interactions with protons at 313 and 371 Mev, distribution of neutrons from charge-exchange and inelastic, 18: 34516 (UCRL-11435)
interactions with protons at 7 and 16 Bev/c, quasi-elastic contribution to, 18: 34520
interactions with protons at 10 Bev/c, meson (π^0) production in, 18: 34542
interactions with protons at 285 Mev, final-state (π–π) effects in, 18: 34552
interactions with protons at 2.5 to 5.5 Bev/c, total cross sections for, 18: 34584
interactions with nucleons, vector meson production in, 18: 34620
interactions with deuterons at zero-energy, branching ratios and cross sections for, 18: 34634
reactions with emulsion nuclei, heavy fragment emission in, 18: 34811
reactions with xenon at 9 Bev/c, meson (π^0) production in, 18: 34949
resonance ($\pi^+\pi^-\eta$) at 959 Mev, properties of, 18: 34515 (UCRL-11431)
resonance ($\pi^+\pi^-$) at 280 to 350 Mev, search for, 18: 34552

MESONS (π^0)
decay, 18: 34574
production in meson (π^-)–proton interactions at 10 Bev/c, 18: 34542
production in meson (π^-) reactions with xenon at 9 Bev/c, cross sections for, 18: 34949

MESONS (π^+)
interactions with protons, phenomenological model for, 18: 34533
interactions with protons, meson (π-ρ) resonance in, 18: 34581
interactions with protons at 2.5 to 5.5 Bev/c, total cross sections for, 18: 34584
interactions with nucleons, vector meson production in, 18: 34620
interactions with protons at 3.54 Bev/c, meson (ρ) exchange mechanism in, 18: 34626
interactions with protons at 3.5 Bev/c, meson (π^+)-meson (π^+) resonance in, 18: 34630
resonance ($\pi^+\pi^-\eta$) at 959 Mev, properties of, 18: 34515 (UCRL-11431)
resonance ($\pi^+\pi^-$) at 280 to 350 Mev, search for, 18: 34552

MESONS (ρ)
exchange in meson (π^+)-proton interactions at 3.54 Bev/c, mechanism of, 18: 34626
interactions with mesons (π), resonance, 18: 34581
production in meson (π)-nucleon interactions, amplitudes and Regge poles for, 18: 34622
review, 18: 34636

MESONS (X)
decay modes and quantum numbers, 18: 34592

METABOLISM
deuterium oxide effects on rat, 18: 33250
radiation effects on sodium, by fish, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on mouse liver histidine, gamma, 18: 33359
radiation effects on rat blood protein, x, 18: 33362
radiation effects on mercaptopropylamine, in mice, 18: 33373
radiosensitivity effects on rats, 18: 33365

METAL COMPLEXES
electron-transfer reactions in solution, mechanisms of, 18: 33521 (BNL-8081)

METAL CRYSTALS
ultrasonic wave attenuation in, 18: 34454

METAL-FOIL DETECTORS
design of fast neutron, 18: 33978(P)
neutron dosimetry using, 18: 33979(P)

METAL POWDERS
fabrication of, method for, 18: 34117(P)

METALLOGRAPHY
visual standards for estimating recrystallization, inclusions, and stringers in uranium, 18: 34047 (NLCO-910)

METALLURGY
physical, effects of quantum mechanical concepts on, 18: 34066
review of metallic reactor fuel, 18: 34130 (TID-8540(p.331-410))

METALS
analysis for gases, vacuum fusion, 18: 33491
analysis for hydrogen, gravimetric, 18: 33538
crystallographic dislocations in, dynamics of, 18: 34122(R) (GA-4900)
deformation by shock waves in explosive forming, 18: 34208
dimensional instability, review, 18: 34121 (DMIC-Memo-189)
effects as interstitial and substitutional solutes on tensile properties of molybdenum, niobium, tantalum, and tungsten, 18: 34203
electronic structure and physical properties of, quantum mechanical concepts for predicting, 18: 34066
heating of liquid, by electron bombardment for boiling studies, 18: 33731 (ANL-6869)
level indicators for liquid, design of ultrasonic, 18: 33830(R) (NYO-10556)
levitation of, review of electromagnetic, 18: 34057 (UCRL-11411)
microwave surface impedance of, with periodic electric conductivity, 18: 34656
mining of, cancer mortality from, 18: 33813
properties of liquid, as reactor working fluids, 18: 35198 (NAA-SR-8617 (Vol.I))
properties of reactor pressure vessel, 18: 34181
radiation and environmental effects in space, 18: 34235
sorptive properties for gases, review of techniques in studies on, 18: 33454
superconductivity in, theory of, 18: 34694
testing thin sheets of, using Lamb waves, 18: 35208

METEORITES
compositional and petrological relations in, 18: 34398
heavy-element isotopic abundances in, 18: 34400
origin of, Monte Carlo analysis of, 18: 34396
oxidation of Urey-Craig, 18: 34397
rare gas content in Renazzo chondrite, 18: 34390
thorium and uranium contents, 18: 34401
xenon isotopic abundance anomalies in, 18: 34399

METEOROLOGY
atmospheric movements, tracer studies on large-scale, 18: 34255
effects of pressure and temperature changes on cosmic-ray intensity data, 18: 34466(T) (NASA-TT-F-126(p.194-214))
effects of wind variability on deposition of stack particles on ground, 18: 33801 (HW-80204)

METHACRYLIC ACID
radioinduced polymerization of menthol esters of, mechanism of polymerization of, 18: 33674

METHACRYLIC ACID, ALLYL ESTERS
effects on radioinduced crosslinking of polyisobutylene, 18: 33652

METHANE
conversion to carbon by pyrolysis, 18: 35246(R) (MLM-1196)
determination in air using kryptonates, 18: 33450(R) (NYO-2757-4)
determination in argon in gas chromatography, electron drift velocity detector for, 18: 33476
determination in metals, vacuum fusion, 18: 33491
ionization of, appearance potential measurements on secondary ions produced by, 18: 33569
radiolysis of hydrogen in deuterated, proton transfer reactions of H_3^+ in, 18: 33639
Ar–methane, specific ionization by curium-244 and uranium-235 fission fragments, 18: 33895
Kr–methane, ionization appearance potential measurements on secondary ions produced by, 18: 33569

METHANE, IODO-
molecule scattering at thermal energies, total cross sections for, 18: 33407 (UCRL-11071)
reactions with iodide and water, calculated carbon-13 and deuterium isotope effects in, 18: 33612 (BNL-8066)
reactions with potassium crossed beams, scattering in, 18: 33564
scattering by molecules at thermal energies, total cross sections for,

18: 34407 (UCRL-11071)
METHANOL
analysis for active hydrogen by NMR spectroscopy, 18: 33475
effects on radioinduced polymerization modification of acrylonitrile, 18: 33650
radiolysis by gammas and recoils, effects of oxygen on, 18: 33618 (CONF-322-14)
solvation of charge groups in, substituent effects on chemical equilibria and rate in, 18: 33613
synthesis of glycol from, radiochemical, 18: 33629
METHYL GROUP
effects on chemical equilibrium and rate of solvation of charge groups in aromatic compounds, 18: 33613
proton spin densities in, 18: 33548
METHYL RED
analytical use for determination of gadolinium in mixture with bromocresol, 18: 33510
MICE
adoptive transfer of sensitivity to allogenic or xenogenic skin grafts in irradiated, 18: 33388
bone marrow aspiration technique for use in, 18: 33223
cerium-144 excretion, effects of DTPA on, 18: 33417
effects of ozone on myocardial cell nuclei in, 18: 33334
iodine-131 uptake by blood plasma, liver, muscles, renal organs, and skin of, 18: 33251
mercaptopropylamine distribution and elimination in, carbon-14-labeled-, 18: 33373
nucleic acid and radiation effects on chromosomes aberrations in, comparison, 18: 33309
polonium removal from, effects of lagochylus on, 18: 33412
radiation effects on testicular zinc-65 uptake in, x, 18: 33270(R) (NIRS-2(p.23-6))
radiation effects on bone composition in, 18: 33276(R) (NYO-910-7)
radiation effects on embryos of, effects on post-natal physiological processes and adult pathology, 18: 33280(R) (TID-20831)
radiation effects on, proton, 18: 33286(T) (UCRL-Trans-1068)
radiation effects on, effects of bone marrow and spleen cell transplants on, 18: 33320
radiation effects on liver cell nuclei in, x, 18: 33350
radiation effects on histidine decomposition in livers of, gamma, 18: 33359
radiation effects on sorption in brain and kidneys of, fission-product, 18: 33358
radiation effects on composition of liver lipids in, gamma, 18: 33360
radiation effects on adrenal glands of, gamma, 18: 33367
radiation effects on central M-choline reactive system in, gamma, 18: 33368
radiation effects on typhoid immunity in, gamma, 18: 33369
radiation effects of bacterial endotoxin sensitivity in, 18: 33370
radiation effects on MPA metabolism, 18: 33373
radiation effects on, recovery from gamma, 18: 33377
radiation effects on, protection against x, 18: 33406
radiation effects on, effects of AET on, 18: 33407
radiation effects on, protective effects of histamine against x, 18: 33414
radiation effects on blood picture and survival of, effects of hormones on, 18: 33416
radiation injuries in, protection against, using previously-aspirated bone marrow, 18: 33223
radiation injuries of, protective effects of amines against, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation protection of embryos of, 18: 33423
radiation sickness of, nucleated cell depletion in bone marrow in, 18: 33351
radioinduced leukemia in, x, 18: 333111
radiosensitivity of, genetic factors affecting, 18: 33281(R) (TID-20844)
radiosensitivity of, prediction by urine potassium–sodium ratios, 18: 33321
radiosensitivity of fetal liver in, 18: 33344
radiosensitivity of skin of, effects of anoxia on, 18: 33408
MICROSCOPES
image brightness intensifiers for, development of, 18: 33221
MICROSCOPY
fluorescence, use in observations on bone marrow during radiotherapy, 18: 33399
MICROWAVE EQUIPMENT
design of mixers using superconducting tunnel diodes, 18: 33824(R) (AD-428788)
plasma characteristics in resonance isolator in rectangular waveguide, 18: 34977(R) (RADC-TDR-64-94)
MICROWAVES
amplification using superconducting films, 18: 34714
emission by cylindrical plasma, 18: 34986
interactions with cryogenic afterglow plasma, 18: 35015
reactions with superconductors of second kind, surface impedance in, 18: 34705
use in plasma diagnostics, 18: 35020
use in plasma diagnostics, controlled mode technique for, 18: 35041
MILK
analysis for radioisotope traces, gamma spectrometric, 18: 33485
MINERALS
distributions in Atlantic sediments, 18: 33790
MINING
cancer mortality in personnel, 18: 33813
methods for broken rock from nuclear explosions, 18: 33710
MITOCHONDRIA
radiation effects on contraction of glycerinated, gamma, 18: 33270(R) (NIRS-2(p.23-6))
MITOSIS
radiation effects on telophase of, microbeams, 18: 33271(R) (NIRS-2(p.26-31))
MOLDS
radiation effects on strawberry grey rot, gamma, 18: 33998
MOLECULES
cross sections for, quantum corrections to transport, 18: 34650
electron scattering by, effects of compound negative ion states in, 18: 34303
flow field of free, over moving circular plate, 18: 33742
friction constant in liquids, use of isotope separation data for calculation of, 18: 34308
isotope effects on dipole moments of linear YXY', 18: 33597
reactions in gases, eigenfunctions of Boltzmann operator for, 18: 34331
Schroedinger equation for, one-electron solution to, 18: 34422
Schroedinger equation for, Monte Carlo evaluation of integrals in, 18: 34423
Schroedinger equation for, ground state energies in, 18: 34424
wave functions of, time-dependent perturbation theory of Hartree-Fock, 18: 34426
MOLLUSKS
paleotemperature analysis of fossil shells, 18: 33784
MOLTEN SALT REACTOR EXPERIMENT
design, 18: 35152 (ORNL-TM-732)
design and fabrication, 18: 35221(R) (ORNL-3626(p.3-58))
hazards analysis, 18: 35152 (ORNL-TM-732)
materials for, production and properties of, 18: 34050(R) (ORNL-3626 (p.59-164))
MOLTEN SALT REACTORS
development, 18: 35064(R) (ORNL-3626)
fuel radiolysis in, 18: 34050(R) (ORNL-3626(p.59-164))
MOLYBDENUM
analysis for carbon, hydrogen, iron, nitrogen, and oxygen, review of methods for, 18: 33516
analysis for hydrogen, nitrogen, and oxygen, vacuum fusion, 18: 33491
analysis for impurities, review of methods for, 18: 33515
bibliography on preparation, fabrication, and uses of, 18: 34151
coating with disilicides, 18: 34209
compatibility with beryllium–thorium–uranium alloy, 18: 34034(R) (BMI-1672(Del.))
conference on refractory metals, Oslo, Norway, June 23 to 26, 1963, 18: 34068
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
corrosion resistance of, effects of alloying and coating on, 18: 34084
determination in MSRE fuel salts, 18: 34050(R) (ORNL-3626(p.59-164))
determination in silicon, activation, 18: 33502
determination of, tracer techniques for, 18: 33483
dislocation motion in single-crystal, induced by electrolytic etching, 18: 34150
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
effects on growth and nitrogen fixation in Nostoc, 18: 33237
effects on tantalum–tungsten alloys, 18: 34059(R) (WANL-PR(Q)-003)
electronic structure, physical properties, and alloying properties, 18: 34202
fabrication and properties for use as superconductors, 18: 34179
fabrication by arc melting, electron-beam melting, and powder metallurgy methods, 18: 34102
fabrication of, mechanical tests to evaluate, 18: 34101
fabrication of, review of primary working operations for, 18: 34104
fabrication, properties, and uses of, review on, 18: 34178
flow forming of, for rocket engine techniques, 18: 34109
gamma coherent scattering at small angles, 18: 35053
mechanical properties of, effects of trace elements on, 18: 34206

neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
oxidation by air and gas mixtures, kinetics of, 18: 34083
physical properties of, effects of alloying additions and chemical reactions on, 18: 34205
preparation of single crystals of, by electron-beam floating-zone melting, 18: 34061(T) (FTD-TT-64-350)
properties for use at high temperatures, 18: 34201
properties of, review on, 18: 34180
radiation effects on, in fluoride salt baths, 18: 34050(R) (ORNL-3626 (p.59-164))
radiation effects on, recovery from neutron, 18: 34221
reactions with plutonium nitride, 18: 34032(R) (BMI-1668(Del.))
reactions with steam, reactor safety studies of, 18: 33678(R) (ANL-6875)
reactions with uranium in alloy with niobium and zirconium, 18: 34174
tensile properties after flow-stress recovery, 18: 34194
tensile properties of, effects of interstitial and substitutional solutes on, 18: 34203
tensile properties of, effects of interaction of interstitial solute and substructure on, 18: 34204
tensile properties of, effects of explosive forming on, 18: 34208
tensile properties of, method of testing, 18: 34210
thermal expansion to 2000°C, 18: 34190
thermophysical properties, 18: 34207
x-ray spectra of, precision redetermination of wavelength of Ka_1 line in, 18: 34341

MOLYBDENUM ALLOYS
conference on refractory metals, Oslo, Norway, June 23 to 26, 1963, 18: 34068
development for high-temperature applications, review, 18: 34069
fabrication and properties for use as superconductors, 18: 34179
fabrication of, mechanical tests to evaluate, 18: 34101
flow forming of, for rocket engine techniques, 18: 34109
properties of, review on, 18: 34180
sheet bending of, methods and problems of, 18: 34107
welding of, electron beam, 18: 34092
welding of, embrittlement in, 18: 34108
Be–Mo, crystal structure of MoB_{12} and MoB_{21}, 18: 34149
Cr–Mo, phase studies based on thermochemical data, 18: 33603
Cr–Mo–Nb, oxidation at 800 to 1200°C, 18: 34080
Fe–Mo–Nb, electric conductivity at 1.5 to 77°K, 18: 34183
Fe–Mo–Re, electric conductivity at 1.5 to 77°K, 18: 34183
Mo–Nb, electric conductivity at 1.5 to 77°K, 18: 34183
Mo–Nb, oxidation kinetics and mechanism of, 18: 34078
Mo–Nb, oxidation at 1000 to 1200°C, 18: 34079
Mo–Nb–Ti, oxidation at 1000 to 1200°C, 18: 34079
Mo–Nb–V–Zr, properties of B-66 foils at high temperatures, effects of coatings on mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)
Mo–Nb–V–Zr, welding of B-66, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Mo–Re, electric conductivity at 1.5 to 77°K, 18: 34183
Mo–Ti–Zr, coating of TZM, with palladium–platinum alloy and platinum, 18: 34029(R) (AD-601740)
Mo–Ti–Zr, properties of TZM foils at high temperatures, effects of coatings on mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)
Mo–Ti–Zr, tensile properties of TZM at room temperature and 650°C, 18: 35060(R) (ANL-6904)
Mo–U, electric and thermal conductivity of, 18: 34143
Mo–U, properties as reactor fuel, 18: 34130 (TID-8540(p.331-410))
Mo–W, corrosion by zinc–molten halide system, 18: 33678(R) (ANL-6875)
Mo–W, phase studies based on thermochemical data, 18: 33603

MOLYBDENUM BORIDES
MoB–MoC, superconducting properties, 18: 34283 (UCRL-11390)

MOLYBDENUM CARBIDES
superconducting transition, effects of structure on, 18: 34283 (UCRL-11390)
MoB–MoC, superconducting properties, 18: 34283 (UCRL-11390)

MOLYBDENUM ISOTOPES Mo-93
preparation and isolation of carrier-free, 18: 33665

MOLYBDENUM ISOTOPES Mo-99
analytical uses, 18: 33483

MOLYBDENUM OXIDES
exchange reactions with oxygen-18, mechanism of, 18: 33545

MOLYBDENUM SILICIDES
coating on refractory metals, cementation processes for, 18: 34091
reactions with beryllium, 18: 34149

MOLYBDENUM STEEL
Cr–Mo, corrosion by flowing sodium, 18: 34073(R) (GEAP-4438)

MOLYBDENUM SYSTEMS
Al–C–Mo, superconducting transition of Mo_3Al_2C, 18: 34283 (UCRL-11390)
Al–C–Mo–Ni–Si–U–Zr, preparation and fabrication as refractory fuel material, 18: 34071(P)
B–Mo–Si, diffusion reactions in boron chloride–hydrogen–silicon chloride, 18: 34146
C–Fe–Mo–Ni, corrosion of HyMu-80 in fluoride volatility process, 18: 34034(R) (BMI-1672(Del.))
Mo–Si–W, deposition on D-14 niobium alloy, 18: 34052 (RTD-TDR-63-4063)

MONEL
welding to inconel, method for, 18: 35093

MONTE CARLO METHOD
formalism for gamma transmission through cylindrical and spherical shields, 18: 35052
meteorite origin analysis by, 18: 34396
neutron density calculations by, spatial-distribution functions for, 18: 34745
use in calculating secondary gamma dose from nuclear weapon explosion, 18: 34285 (WL-TDR-64-46(Vol.I))
use in evaluation of integrals in molecular Schroedinger equation, 18: 34423
use in neutron production in proton reactions with heavy nuclei at 0.3 to 1.0 Bev, 18: 34961

MOON
effects on geomagnetic activity, 18: 34677

MORPHOLINE
complexes with europium benzoylacetonate, ligand field spectra of, 18: 33565

MÖSSBAUER EFFECT
book: *Mossbauer Effect and Its Application in Chemistry*, 18: 33604(T)
diffraction in nuclear resonant scattering, 18: 34929
measurement of, velocity spectrometer for, 18: 33834 (RT/EL(63)-15)
review, 18: 34298

MOTORS
energy conversion characteristics of brushless d-c, 18: 34498 (UCRL-11334)
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))

MUCOPROTEINS
radiation effects on, in rat connective tissue, 18: 33277 (STI/DOC/10/28(p.21-38))

MULTIPLICATION FACTOR
fast fission factors in slightly enriched light water-moderated slab lattices, 18: 35117
measurement of negative, use of spectral density of neutron fluctuations for, 18: 35074 (TID-7679(p.171-81))

MUONIUM
hyperfine structure interval for, 18: 34921

MUSCLES
cesium-137 uptake from fallout by, 18: 33427
iodine-131 uptake by, in animals and chickens, 18: 33251

MUTATIONS
effects of storage on Drosophila spermatozoa, 18: 33273(R) (NIRS-2(p.42-8))
radio- and mutagen-induced in *Vicia faba*, x, 18: 33303
radioinduced host-range, in T2 bacteriophage, gamma, 18: 33297
radioinduced in asparagus, 18: 33323
radioinduced in carnations, gamma, 18: 33302
radioinduced in cotton seed, 18: 33313
radioinduced in Drosophila, effects of arginine on, 18: 33371
radioinduced in homozygote and isogenic Saccharomyces yeast strains, ploidy effects on, 18: 33394
radioinduced in maize and wheat, 18: 33279(R) (TID-20823)
radioinduced in mice, 18: 33281(R) (TID-20844)
radioinduced in plants, 18: 33213 (STI/DOC/10/28(p.79-103))
radioinduced in wheat, fast-neutron, 18: 33374
radioinduced, in *Phaseolus mungo*, x, 18: 33324

N

NAGASAKI
radiation injuries in adolescents of, 18: 33391

NAPHTHALENES
fluorescence decay time in deuterated and natural, device for measuring, 18: 33637
phosphorescence decay time in deuterated and natural, device for measuring, 18: 33637

NAVAL VESSELS
nuclear propulsion systems for, 18: 35205

NECK
diagnosis of esophagus cancer by differential uptake of phosphorus-32, 18: 33438
NEODYMIUM
photoelectric effect in, relativistic, 18: 34847
NEODYMIUM ALLOYS
Cd–Nd, formation of $NdCd_{11}$ compound, free energy of, 18: 35060(R) (ANL-6904)
Mg–Nd, effects of plastic deformation on properties and structure of, 18: 34148
Sb–Nd, electric properties and uses of, 18: 34158
NEODYMIUM ARSENIDES
electric properties and uses of, 18: 34158
NEODYMIUM COMPOUNDS
deposition on silicon, 18: 34034(R) (BMI-1672(Del.))
NEODYMIUM IONS
distribution between phases in boron oxide–sodium chloride–sodium oxide system at 830°C, 18: 33534 (USNRDL-TR-760)
NEODYMIUM ISOTOPES
yields from uranium-235 fission, 18: 34006(R) (ORNL-TM-889)
NEODYMIUM OXIDES
Nd_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Nd_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
NEODYMIUM TELLURIDES
electric properties and uses of, 18: 34158
NEON
atom interaction energy in solid, repulsive, 18: 34413
cesium optical pumping in, spin relaxation time in, 18: 33566
crystal stability of, three-body interactions in, 18: 34706
electron scattering by, excitation cross sections for, 18: 34430
ion diffusion and drift in, positive, 18: 34449
microwave interaction in afterglow plasma of, 18: 35015
potassium scattering at thermal energies, total cross sections for, 18: 34407 (UCRL-11071)
reactions with inert-gas atoms, van der Waals forces for, 18: 34345
NEON IONS
diffusion and drift of positive, in neon, 18: 34449
reactions with ethylene molecules at 200 and 400 kev, mass spectra of fragments from, 18: 34433
recombination of diatomic positive, with electrons, 18: 34259 (AD-434907)
scattering by rare gases at 80 kev, energy losses from, 18: 34416
spectra of VII and VIII, wavelengths in vacuum ultraviolet, 18: 34384
NEON ISOTOPES
content in Renazzo chondrite, 18: 34390
separation by thermal diffusion, 18: 35246(R) (MLM-1196)
NEON ISOTOPES Ne-16
production and decay in neon-20 reactions with nickel, possible, 18: 34765 (JINR-P-1679)
NEON ISOTOPES Ne-17
beta decay of, proton emission following, 18: 34899
NEON ISOTOPES Ne-20
alpha reactions (α,d) at 45 to 50 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
energy level de-excitation branching in, 18: 34842
energy levels, 18: 34869
energy levels, 18: 34958
energy levels, 18: 34829
reactions (Ne-20, Na-24) with gold-197 and uranium-238, angular distributions in, 18: 34763 (JINR-P-1675)
reactions with nickel at 150 Mev, possible production and detection of neon-16 in, 18: 34765 (JINR-P-1679)
NEON ISOTOPES Ne-21
energy levels of, parameters for, 18: 34849
separation by thermal diffusion, 18: 34005(R) (ORNL-TM-879)
NEON ISOTOPES Ne-22
deuteron reactions (d,n) at 2.75 Mev, neutron emission in, 18: 34832
reactions with scandium-45 at 60 to 160 Mev, production of scandium-44 isomer pairs in, 18: 34948
NEPTUNIUM
electric conductivity at 300°K, reduced Ziman, 18: 34164
vapor pressure at 1700 to 1950°K, 18: 33570
NEPTUNIUM ALLOYS
Np–Pu, structure of single crystal of, 18: 34171
NEPTUNIUM COMPLEXES
with bromide and chloride in solutions, spectrophotometric and ion exchange studies, 18: 33526 (IA-924)
NEPTUNIUM ISOTOPES Np-237
electrodeposition on nickel, 18: 34005(R) (ORNL-TM-879)
energy levels of, half life of 60-kev, 18: 34813
gamma decay, 18: 34802
Mossbauer effect in neptunium oxides, 18: 34920
NEPTUNIUM ISOTOPES Np-239
energy levels, 18: 34850
NEPTUNIUM OXIDES
neptunium-237 Mossbauer effect in, 18: 34920
NERVE CELLS
radiation effects on Nissl granules in rat spinal cord, 18: 33349
NERVOUS SYSTEM
effects of bromide on conditioned reflexes in dogs, 18: 33319
radiation effects from deposited phosphorus-32 on, in rat, 18: 33278 (STI/DOC/10/28(p.39-66))
radiation effects on conditioned reflexes in normal and bromide-treated dogs, 18: 33319
radioinduced necroses of central, delayed post-therapeutic, 18: 33290
radiosensitivity of, in cats and rats, 18: 33278 (STI/DOC/10/28(p.39-66))
radiosurgery of, strontium-90 needle for, 18: 33436
NEUTRAL RED
effects of X agent on precipitation or crystallization of, 18: 33671
effects of X agent on precipitation or crystallization of, 18: 33672
effects of X agent on precipitation or crystallization of, 18: 33673
NEUTRINOS
emission by excited nuclei, pair, 18: 34932
interactions with nucleons, conserved vector current hypothesis testing by, 18: 34561
interactions with electrons, spin correlations in, 18: 34614
isospinor field for, 18: 34527
theory of electron- and meson (μ)-associated, 18: 34598
NEUTRON-ABSORPTION ANALYSIS
instrument for measuring moisture in friable materials, 18: 33466(T) (AEC-tr-6399(p.43-50))
of friable bodies for moisture, instrument for, 18: 33470(T) (AEC-tr-6399(p.83-91))
NEUTRON BEAMS
research program using, 18: 34799
uses of thermal, for radiography, 18: 33995
NEUTRON CAPTURE CROSS SECTIONS
calculation of fast neutron removal cross sections, 18: 34888
measurement for erbium-170, gadolinium-158, and rhenium, 18: 33678(R) (ANL-6875)
NEUTRON CROSS SECTIONS
bibliography on, of threshold reactions, 18: 34753(R) (EANDC(E)-50(L))
measurement during high-altitude nuclear explosions, time-of-flight, 18: 34751 (CONF-481-71)
tables of total and partial, for uranium-236 for 1 kev to 15 Mev, 18: 34750 (AWRE-O-30/64)
NEUTRON DIFFRACTOMETERS
design and operation, 18: 33881 (NP-14131)
NEUTRON PHOTOGRAPHY
equipment for, using thermal neutron beam from Juggernaut Reactor, 18: 33995
NEUTRON SCATTERING CROSS SECTIONS
intermediate resonance structure in, 18: 34768 (MIT-2098-61)
NEUTRON SOURCES
design of portable pulsed, 18: 34749(P)
flux distributions from point, in water system with internal spherical cavity, 18: 34731 (NASA-CR-54110)
NEUTRON SPECTRA
determination of multigroup, computer program for, 18: 34730 (KR-77)
measurement in reactors, 18: 35066 (STI/DOC/10/28(p.73-7))
measurement of deviation from 1/E distribution in epicadmium, 18: 34735
NEUTRON SPECTROMETERS
control of systems of, computer, 18: 33876 (BNL-8180)
data processing system for time-of-flight, computerized, 18: 33958
design and performance of time-of-flight, 18: 33944
design of time-of-flight scintillation, 18: 34752(R) (CU(PNPL)-234)
NEUTRON TOTAL CROSS SECTIONS
measurement for gadolinium, holmium, and rhenium, 18: 33678(R) (ANL-6875)
NEUTRONS
absorption in hafnium, cross sections for resonance, 18: 34883
beta decay, 18: 34799
binding energies in A = 91 to 209 nuclei, determination from (d,p) and (d,t) reactions, 18: 34966
buckling in water-moderated slightly enriched uranium lattices, 18: 35113 (TID-8540(p.529-609))
capture by boron-10, use in radiotherapy of brain tumors, 18: 33431 (TID-20856)
capture by nuclei at 30 and 65 kev, cross sections for radiative, 18: 34274(R) (NIRS-2(p.3-15))
capture by samarium and tin isotopes at 30 kev, cross sections for

radiative, 18: 34274(R) (NIRS-2(p.3-15))
density distributions in heavy-water-moderated lattices, 18: 35143(R) (DP-915)
density fluctuations in zero-power reactors, equations for, 18: 35080 (TID-7679(p.347-55))
density in slabs and half spaces, spatial-distribution functions for calculating, 18: 34745
detection and discrimination from gamma rays, 18: 34752(R) (CU(PNPL)-234)
detection at high temperatures, silicon carbide detector for, 18: 33918
detection using scintillation spectrometers, pulse-height spectra in, 18: 33925
diffusion and thermalization in materials, 18: 34752(R) (CU(PNPL)-234)
diffusion equation for, generalized endpoint method for solving, 18: 35056
diffusion in heavy water-moderated systems, calculational methods for, 18: 35112 (RISÖ-81)
diffusion in homogeneous lattices, computer program for multigroup, 18: 34730 (KR-77)
diffusion length of, exact equations for, 18: 34742
distribution in hydrogenous moderators, second spatial moment of, 18: 34736
dosimetry in reactors, review of methods for, 18: 33879 (HW-SA-3585)
dosimetry in tissues, 18: 33431 (TID-20856)
dosimetry using double-moderator detector, 18: 33951
effects on dimensions of graphite bars, 18: 34231
effects on electric conductivity of aluminum, annealing of, 18: 34222
effects on electrodes in nickel–cadmium batteries, 18: 34213(R) (AI-64-11)
effects on fused chloride and fluoride salts, 18: 34050(R) (ORNL-3626 (p.59-164))
effects on low-melting organic coolants, 18: 33617 (AECI-1915)
effects on mechanical properties of niobium-stabilized stainless steel, 18: 34218 (ORNL-TM-881)
effects on molybdenum, recovery from, 18: 34221
effects on pyrolytic graphite at high temperatures, 18: 34232
effects on radiation-resistant electronic equipment, 18: 33869
effects on silicon avalanche diodes, single collision, 18: 34248
effects on superconductors, 18: 34683(R) (NP-14136)
effects on tellurium compounds, chemical state of iodine-131 formed in, 18: 33661
effects on thermal conductivity of pyrolytic graphite, 18: 34033(R) (BMI-1669(Del.))
effects on tree growth, 18: 33282 (TID-20876)
effects on zeolites, 18: 35234(R) (HW-81862)
filtering of, performance of bismuth and quartz crystals for, 18: 34752(R) (CU(PNPL)-234)
flux density fluctuations in Halden BWR-I, experiments for, 18: 35157 (TID-7679(p.449-68))
flux distribution in power reactors, development of equipment for monitoring, 18: 35247(R) (NAA-SR-9700)
flux distributions in water system with internal cavity, 18: 34731 (NASA-CR-54110)
flux of, nomographs for monitoring by activation methods, 18: 34012
interactions with deuterons at 32 and 40 Mev, impulse approximation for elastic, 18: 34537
interactions with protons, charge-independent pairing in, 18: 34600
interactions with mesons (π) and photons, vector meson production in, 18: 34620
interactions with protons, meson effects in nuclear, 18: 34915
multiplication at surface of transport containers, adjoint-problem calculation of, 18: 34726 (AWRE-O-21/64)
multiplication in pulsed media, C(R) analysis of, 18: 34495 (GA-5404)
multiplication in reactors, stochastic models for, 18: 35070 (TID-7679 (p.29-59))
noise analysis of reactor system, 18: 35073 (TID-7679(p.155-69))
pairing forces in deformed nuclei, 18: 34939
polarizability of, electric and magnetic, 18: 34526
polarizability of, from photon scattering by helium, 18: 34538
polarization in deuterium (d,n) helium-3 reactions, 18: 34963
production and polarization in meson (π^-)–proton interactions at 310 Mev, 18: 34512 (UCRL-11140)
production in meson (π^-)–proton interactions at 313 and 371 Mev, cross sections for, 18: 34516 (UCRL-11435)
production in proton reactions with heavy nuclei at 0.3 to 1.0 Bev, 18: 34961
pulsed techniques for reactivity measurements, 18: 35076 (TID-7679 (p.219-28))
pulsed techniques for impulse-response of reactors, cross-correlation techniques with random excitation for, 18: 35075 (TID-7679(p.203-18))
reactions (n,α) of, angular distribution for, 18: 34876
reactions (n,α) with nuclei at 14 Mev, total cross sections for, 18: 34887
reactions (n,α) with nuclei, direct interaction model for knockout and pickup, 18: 34769 (NP-14085)
reactions (n,α) of, statistical model analysis of, 18: 34810
reactions (n,α) with calcium-40 at 14 Mev, differential cross sections for, 18: 34841
reactions (n,γ) with promethium-147, macroscopic cross section for, 18: 34006(R) (ORNL-TM-889)
reactions (n,γ) with nuclei, relation between cross section and scattering length for, 18: 34762 (JINR-P-1671)
reactions (n,γ) with cobalt-59, 18: 34827
reactions (n,d) with oxygen-16 at 14 Mev, distorted-wave approximation for, 18: 34774 (ORNL-P-144)
reactions (n,d) with sulfur-32 at 14 Mev, 18: 34818
reactions (n,p) with iron-54, cross section of, 18: 34885
reactions (n,t) with boron-10 at 14.4 Mev, triton angular distributions in, 18: 34830
reactions on magnetic oxides, total cross sections for, 18: 34752(R) (CU(PNPL)-234)
reactions with fuels in fast ceramic reactors, cross sections for, 18: 35146(R) (GEAP-4601)
reactions with nuclei, nomographs for induced radioactivity in, 18: 34012
reactions with nuclei, tunneling in Coulomb field in, 18: 34894
reactions with nuclei, bibliography on cross sections for, 18: 34753(R) (EANDC(E)-50(L))
reactions with nuclei in activation analysis, parameters for, 18: 33492
resonance integrals of, approximation for, 18: 34741
resonance integral calculations for lattices, effective surface in calculation of, 18: 34744
scattering by anharmonic crystals, scattering function for inelastic, 18: 34460
scattering by anharmonic crystals, functions for inelastic, 18: 34748
scattering by closed-shell nuclei, intermediate resonances in, 18: 34768 (MIT-2098-61)
scattering by crystals, 18: 34455
scattering by heavy nuclei, analysis of inelastic, 18: 34910
scattering by iron at 2 to 5 Mev, inelastic, 18: 34740
scattering by nuclei at 1 Mev, optical model analysis of elastic, 18: 34828
scattering by nuclei, diffraction mechanism for elastic, 18: 34848
scattering by water, kernel for, 18: 34739
scattering in biphenyl, spectra of inelastic, 18: 34302
scattering of, theory of, 18: 34624
self-shielding factor of cobalt-60 foil for, 18: 34737
slowing-down equation for, constant solution of, 18: 34747
spectra in light-water-moderated reactors, computer analysis of, 18: 35128(R) (GEAP-4642)
spectral density of fluctuations of, negative reactivity measurements from, 18: 35074 (TID-7679(p.171-81))
thermalization in infinite homogeneous media, theory of, 18: 34727 (CEA-R-2368)
transfer functions for, use of power spectra in reactor-system analysis of, 18: 35071 (TID-7679(p.107-33))
transmission coefficients for, s-wave, 18: 34866
transmission through nickel-coated copper tubes, 18: 34752(R) (CU(PNPL)-234)
transport equation in plane geometry for, transformation of, 18: 34743
transport in cylindrical geometry, FORTRAN II program for IBM 7090, 18: 34729 (IDO-16968)
transport in fast ceramic reactors, theory, 18: 35146(R) (GEAP-4601)
transport in finite nonabsorbing slab, with isotropic elastic scattering, 18: 34746
transport in organic moderator, 18: 34734
transport in slab geometry, modified P_1 approximations to equations for, 18: 34728 (DTMB-1814)
transport in slab geometries, computer programs for, 18: 34732 (WAPD-TM-436)
yields from deuterium (d,n) and tritium (d,n) reactions, 18: 34815

NEUTRONS, FAST

angular distribution for photo-, calculation of, 18: 34935
attenuation by concretes, 18: 35092(T) (JPRS-25467(p.1-8))
capture and inelastic scattering on indium-113 and -115, cross sections for, 18: 34962
capture-to-fission ratio of uranium-235 at 12 to 690 kev, 18: 34886
chemical effects on terphenyls, 18: 33619 (MITNE-48)
detection and measurement using indium, method for, 18: 33978(P)
dosimetry for radiation damage studies, 18: 34263 (ANL-6826)
dosimetry using boron trifluoride detectors, method for, 18: 33980(P)
dosimetry using fission foils, method for direct, 18: 33979(P)
effects on aging and resistivity of aluminum–magnesium alloys, 18: 34244

effects on beryllium oxide compacts at 583 to 1100°C, 18: 34224
effects on crystal structure of carbonates, oxides, and titanates, 18: 34241
effects on magnetic amplifier control devices for nuclear ramjets, 18: 33825 (AD-435095)
effects on mechanical properties of 1100 aluminum, 18: 34032(R) (BMI-1668(Del.))
effects on mechanical properties of 1100 aluminum, 18: 34033(R) (BMI-1669(Del.))
effects on microstructure of hot-pressed beryllium oxide, annealing effects on, 18: 34225
effects on microstructure of sintered beryllium oxide, 18: 34226
effects on pressure-vessel steels, research program on, 18: 34219 (RCN-26)
effects on strontium titanate single crystals, 18: 34246
effects on thermoelectric properties of semiconductors, 18: 34237
flux distributions of pulsed, in multiplying and non-multiplying uranium systems, 18: 34738
mutagenic effects in asparagus, 18: 33323
mutagenic effects on winter wheat, 18: 33374
reactions with americium-243 at 14 Mev, formation of spontaneously fissioning isomer in, 18: 34759 (JINR-D-1693)
reactions with lithium-drifted silicon detectors, damage effects in, 18: 33913
reactions with nuclei, removal cross sections for, 18: 34888

NEUTRONS, PROMPT
lifetimes in critical assemblies of enriched uranium, 18: 34496
lifetimes in reflected uranium–heavy water systems, 18: 35116

NEUTRONS, RESONANCE
reactions with gold and uranium-238, 18: 35247(R) (NAA-SR-9700)

NEUTRONS, THERMAL
attenuation by concretes, 18: 35092(T) (JPRS-25467(p.1-8))
detection of, liquid scintillator system for, 18: 33953
flux distributions in water system with internal cavity, 18: 34731 (NASA-CR-54110)
flux distributions in exponential piles, time-dependent, 18: 35225
propagation of burst of, through extended multiplying system, 18: 35247(R) (NAA-SR-9700)
reactions (n,γ) with silicon semiconductors, phosphorus-31 production in, 18: 33920
reactions with plutonium-241, cross section for fission, 18: 34914
scattering by non-axially symmetric deformed potential, s-wave intensity function in, 18: 34787
scattering in materials, 18: 34752(R) (CU(PNPL)-234)
self-shielding effects of metals against, in activation studies, 18: 33488
spectra in water with absorbers, 18: 34733

NICHROME
krypton-85 release from stressed wire of, 18: 33450(R) (NYO-2757-4)
kryptonation of wire of, 18: 33450(R) (NYO-2757-4)

NICKEL
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
alpha reactions with, secondary electron emission from, 18: 33911
cavitation by liquid sodium, 18: 34075 (NASA-CR-54071)
contents in meteorites, 18: 34398
determination in silicon, activation, 18: 33502
determination of traces of, in water by atomic absorption spectrometry, 18: 33461 (DP-879)
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
effects on radiation damage in silicon crystals, 18: 34228
effects on sintering rates of tungsten, 18: 34098
electron scattering by, energy loss mechanisms in relativistic, 18: 34258(R) (AD-417250)
gamma reactions (γ,n) with, neutron angular distribution from, 18: 34935
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
oxygen-16 reactions at 167 Mev, charged-particle emission in, 18: 34780 (UCRL-11349)
properties as coatings on copper neutron-transmission tubes, 18: 34752(R) (CU(PNPL)-234)
radiodermatitis effects on content of, in skin and blood, 18: 33285(T) (JPRS-25502)
separation from thorium and uranium by paper chromatography, 18: 33505
separation from zirconium by ion exchange on pyrocatechol-*O,O*-diacetic acid, 18: 33508
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
surface properties for molten chloride and fluoride salts, 18: 34050(R) (ORNL-3626(p.59-164))
welding of, characteristics of electron beam, 18: 34112

NICKEL ALLOYS
properties as fuel element cladding in steam and water environments, 18: 34076 (TID-8540(p.213-330))
Al–Ni–U, reactions with steam, reactor safety studies of, 18: 33678(R) (ANL-6875)
Cr–Ni, lubrication by fused fluoride coatings in air, hydrogen, liquid sodium, and vacuum, 18: 33695 (NASA-TN-D-2348)
Fe–Ni, composition dependence of spin wave energies in, 18: 34187
Ni–Y, gadolinium EPR in, 18: 33587
Ni–Zr, corrosion by steam at 400°C, hydrogen sorption during, 18: 34060(T,R) (EURAEC-1062)
Ni–Zr, embrittlement effects of hydrogen on, 18: 34169

NICKEL ELECTRODES
radiation effects on, in nickel–cadmium batteries, 18: 34213(R) (AI-64-11)

NICKEL FLUOSILICATES
nuclear magnetic resonance of fluorine and protons in, at 0.15 to 4.2°K, 18: 34275 (NP-14114)

NICKEL ISOTOPES
energy level calculations for, with pairing interaction, 18: 34927
neon-20 reactions at 150 Mev, possible production and detection of neon-16 in, 18: 34765 (JINR-P-1679)
separation in calutrons, 18: 34007(R) (ORNL-TM-890)
separation of stable, in calutrons, 18: 34005(R) (ORNL-TM-879)

NICKEL ISOTOPES Ni-58
energy levels, 18: 34906
proton reactions (p,α) at 11 to 12.5 Mev, 18: 34855

NICKEL ISOTOPES Ni-60
energy levels of, lifetime of second excited, 18: 34752(R) (CU(PNPL)-234)

NICKEL ORES
Cu–Ni, sulfur-34 content in sulfides from Soviet Union deposits of, 18: 33767

NICKEL SYSTEMS
Al–C–Mo–Ni–Si–U–Zr, preparation and fabrication as refractory fuel material, 18: 34071(P)
C–Fe–Mo–Ni, corrosion of HyMu-80 in fluoride volatility process, 18: 34034(R) (BMI-1672(Del.))

NICOTINIC ACID
protective effects against radiation effects on amino acid content in wheat sprouts, 18: 33398

NINE MILE POINT POWER REACTOR
economic comparison with CANDU Reactor, 18: 35172

NIOBIUM
analysis for carbon, hydrogen, iron, nitrogen, and oxygen, review of methods for, 18: 33516
analysis for hydrogen, nitrogen, and oxygen, vacuum fusion, 18: 33491
analysis for hydrogen, gravimetric, 18: 33538
analysis for impurities, review of methods for, 18: 33515
analysis for sulfur, luminescent method for, 18: 33513
analysis for tantalum traces, x-ray spectrographic, 18: 33458 (BM-RI-6483)
bibliography on analytical chemistry of, 18: 33482
bibliography on preparation, fabrication, and uses of, 18: 34151
coating with disilicides, 18: 34209
compatibility with beryllium–thorium–uranium alloy at 1500°F, 18: 34032(R) (BMI-1668(Del.))
compatibility with beryllium–thorium–uranium alloy, 18: 34034(R) (BMI-1672(Del.))
conference on refractory metals, Oslo, Norway, June 23 to 26, 1963, 18: 34068
corrosion resistance of, effects of alloying and coating on, 18: 34084
creep tests at low temperatures, 18: 34119 (ATN-64(9236)-9)
crystallographic dislocations in, dynamics of, 18: 34122(R) (GA-4900)
determination of, tracer techniques for, 18: 33483
electron states in superconducting, 18: 34708
electronic structure, physical properties, and alloying properties, 18: 34202
fabrication and properties for use as superconductors, 18: 34179
fabrication of powdered, method for, 18: 34117(P)
fabrication of, mechanical tests to evaluate, 18: 34101
fabrication of, review of primary working operations for, 18: 34104
fabrication, properties, and uses of, review on, 18: 34178
internal friction in plastically deformed bcc, 18: 34039(R) (GA-5340)
magnetic properties at low temperatures, 18: 34712
mechanical properties of, effects of trace elements on, 18: 34206
oxidation by air and gas mixtures, kinetics of, 18: 34083
physical properties of, effects of alloying additions and chemical reactions on, 18: 34205
polarization in aqueous sulfate solutions, electrochemistry of passivating oxide film formed in, 18: 34063

preparation, properties, and uses of, review on, 18: 34189
production by arc reduction of niobium carbide and oxide mixture, 18: 34067
properties for use at high temperatures, 18: 34201
properties of, review on, 18: 34180
reactions with plutonium nitride, 18: 34032(R) (BMI-1668(Del.))
separation from tantalum by solvent extraction using hydrofluoric acid–TBP, 18: 33688
solvent properties for nitrogen and oxygen, 18: 34177
superconducting critical fields in, 18: 34704
superconducting properties of evaporated and sputtered films of, 18: 34157
superconductivity of, upper critical field for, 18: 34713
tensile properties of wrought, effects of oxygen on, 18: 34196
tensile properties of, effects of interstitial and substitutional solutes on, 18: 34203
tensile properties of, effects of interaction of interstitial solute and substructure on, 18: 34204
tensile properties of, method of testing, 18: 34210
thermal expansion to 2000°C, 18: 34190
thermophysical properties, 18: 34207
welding of, electron-beam and tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
welding of, embrittlement in, 18: 34108

NIOBIUM ALLOYS
conference on refractory metals, Oslo, Norway, June 23 to 26, 1963, 18: 34068
development for high-temperature applications, review, 18: 34069
fabrication and properties for use as superconductors, 18: 34179
fabrication of, mechanical tests to evaluate, 18: 34101
properties as fuel element cladding in steam and water environments, 18: 34076 (TID-8540(p.213-330))
properties of, review on, 18: 34180
sheet bending of, methods and problems of, 18: 34107
welding of, embrittlement in, 18: 34108
Al–Nb, radiation effects of neutrons on superconductivity of, 18: 34683(R) (NP-14136)
Al–Nb, superconducting transition of Nb_3Al, effects of vanadium on, 18: 34283 (UCRL-11390)
Co–Nb, crystal structure of beta phase of, 18: 34145
Co–Nb, solvent properties for silicon in beta phase of, 18: 34145
Cr–Mo–Nb, oxidation at 800 to 1200°C, 18: 34080
Fe–Mo–Nb, electric conductivity at 1.5 to 77°K, 18: 34183
Hf–Nb, phase studies on, 18: 34163
Hf–Nb–W–Y, welding of C-129Y, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Mo–Nb, electric conductivity at 1.5 to 77°K, 18: 34183
Mo–Nb, oxidation kinetics and mechanism of, 18: 34078
Mo–Nb, oxidation at 1000 to 1200°C, 18: 34079
Mo–Nb–Ti, oxidation at 1000 to 1200°C, 18: 34079
Mo–Nb–V–Zr, properties of B-66 foils at high temperatures, effects of coatings on mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)
Mo–Nb–V–Zr, welding of B-66, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Nb–Sn, crystallography and phase equilibrium in, 18: 34165
Nb–Sn, properties for use as superconductive wires, 18: 34200
Nb–Sn, radiation effects of neutrons on superconductivity of, 18: 34683(R) (NP-14136)
Nb–Sn, superconducting magnets of, 18: 34715
Nb–Ta, phase studies based on thermochemical data, 18: 33603
Nb–Ta–W, welding of SCb-291, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Nb–Ta–W–Zr, coating of FS-85, with palladium–platinum alloy and platinum, 18: 34029(R) (AD-601740)
Nb–Ta–W–Zr, welding of FS-85, electron-beam and tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Nb–Ti, oxidation at 1000 to 1200°C, 18: 34079
Nb–Ti, superconductivity of, surface effects on, 18: 34683(R) (NP-14136)
Nb–Ti–Zr, properties of D-36 foils at high temperatures, effects of coatings on mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)
Nb–U, properties as reactor fuel, 18: 34130 (TID-8540(p.331-410))
Nb–U, structure of, effects of cooling rate from gamma phase on, 18: 34127 (RT/MET(64)-2)
Nb–U–Zr, reactions of molybdenum with uranium in, 18: 34174
Nb–W, tensile properties of, effects of carbon, vanadium, and zirconium on, 18: 34197
Nb–W–Zr, fabrication and properties of Cb-752 sheet, 18: 34025(R) (AD-428036)
Nb–W–Zr, welding of Cb-752 and D-43, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Nb–Zr, coating of D-14 for oxidation protection, 18: 34052 (RTD-TDR-63-4063)
Nb–Zr, current-carrying capacity of superconducting, temperature and field dependence of, 18: 34681 (BSD-TDR-64-87)
Nb–Zr, embrittlement effects of hydrogen on, 18: 34169
Nb–Zr, magnetic flux jumps in superconducting, 18: 34724
Nb–Zr, properties for use as superconductive wires, 18: 34200
Nb–Zr, superconducting magnets of, 18: 34715

NIOBIUM CARBIDES
NbC–TaC, superconducting properties of solid solutions of, 18: 34684 (UCRL-11368)

NIOBIUM ISOTOPES Nb-93
proton reactions (p,n) at 7 to 13 Mev, 18: 34859

NIOBIUM ISOTOPES Nb-95
analytical uses, 18: 33483
content in fallout in French Territory, 18: 33770 (SCPRI(S)-90)
determination in liquids, gamma spectrometric, 18: 33485
determination in urine and feces of, gamma spectrometric, 18: 33264
gamma spectra of, least-squares analysis of, 18: 33926
separation from zirconium-95 by ion exchange on pyrocatechol-*O,O*-diacetic acid, 18: 33508
sorption by river silts, 18: 35238 (STI/DOC/10/28(p.9-20))

NIOBIUM NITRIDES
superconducting properties of evaporated and sputtered films of, 18: 34157

NIOBIUM OXIDES
analysis for sulfur, luminescent method for, 18: 33513
effects on density of sintered uranium dioxide, 18: 35060(R) (ANL-6904)
electrochemistry of passivating films of, formed on metal by polarization, 18: 34063
Al_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
CeO_2–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Dy_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Ga_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Gd_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
In_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
La_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Nd_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Sc_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Sm_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Ti_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Y_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199

NIOBIUM SELENIDES
structural properties of, 18: 34137

NIOBIUM SYSTEMS
Al–C–Nb, superconducting transitions in, 18: 34283 (UCRL-11390)
C–Nb–Zr, phase studies on, 18: 34211
Nb–N, equilibrium in, 18: 34177
Nb–O, superconducting critical fields in, 18: 34704
Nb–O–Zr, phase studies on, 18: 34211

NIOBIUM TELLURIDES
crystal structure of, 18: 34136

NITRIC ACID
effects on ion exchange properties of titanium and zirconium salts, 18: 33535

NITROGEN
determination in argon in gas chromatography, electron drift velocity detector for, 18: 33476
determination in metals, vacuum fusion, 18: 33491
determination in refractory metals, review of methods for, 18: 33515
determination in refractory metals, review of methods for, 18: 33516
diagnostics of afterglow plasma of, 18: 34999
effects on tantalum–tungsten alloys, 18: 34059(R) (WANL-PR(Q)-003)
electron reactions at 1.7 to 3.5 ev, vibrational excitation in, 18: 34440
electron scattering by, mechanism of excitation and de-excitation of molecular vibration in, 18: 34304
in mobilities in liquid, positive, 18: 34343
nuclear magnetic shielding in, theory of, 18: 33563
potential energy curves, 18: 34281 (RM-4034-PR)
radiation and burn injury effects on content of, in rats, 18: 33381
reactions with ionic, calculations of charge exchange and charge exchange and diffusion cross sections for, 18: 34418
separation from argon by gettering on hot titanium sponge, 18: 33678(R) (ANL-6875)
solubility in niobium, 18: 34177
solubility in tantalum at 350 to 2300°C, 18: 33595
spectra of, isotope shifts and vibrational structure of weaker systems in, 18: 33568

NITROGEN FIXATION
of Nostoc, effects of calcium, cobalt, molybdenum, and strontium on, 18: 33237

NITROGEN IONS

potential energy curves for molecular, 18: 34281 (RM-4034-PR)
reactions with ethylene molecules at 200 and 400 kev, mass spectra of fragments from, 18: 34433
reactions with nitrogen, calculations of charge exchange and charge exchange and diffusion cross sections for, 18: 34418
recombination of diatomic positive, with electrons, 18: 34259 (AD-434907)
NITROGEN ISOTOPES
biological effects of, nuclear-man, 18: 33258
NITROGEN ISOTOPES N-12
beta decay of, conserved-vector-current theory for, 18: 34752(R) (CU(PNPL)-234)
NITROGEN ISOTOPES N-13
recoil reactions with sodium azide, activities of yields in, 18: 33663
NITROGEN ISOTOPES N-14
alpha reactions (α,d) at 45 to 50 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
electron inelastic scattering at 121 and 180 Mev, 18: 34825
energy level population in (α,d) reactions, 18: 34779 (UCRL-11341)
energy levels, 18: 34825
energy levels of, tensor force effects on, 18: 34838
nuclear quadrupole relaxation in organic compounds, 18: 33615
reactions (N-14,N-13) with rhodium at 10 Mev, differential cross sections for, 18: 34951
scattering by nuclei, diffraction mechanism for elastic, 18: 34848
NITROGEN ISOTOPES N-15
alpha reactions (α,d) at 45 to 50 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
spectra of, isotope shifts and vibrational structure of weaker systems in, 18: 33568
NITROGEN OXIDES
effects on chemical equilibrium and rate of solvation of charge groups in aromatic compounds, 18: 33613
positron annihilation in, 18: 34752(R) (CU(PNPL)-234)
potential energy curves for nitric oxide molecules and ions, 18: 34281 (RM-4034-PR)
recombination of positive ions of, with electrons, 18: 34259 (AD-434907)
synthesis of glycol from, radiochemical, 18: 33629
NO–SF_6, recombination rates for gaseous, 18: 33555
NITROGEN SYSTEMS
C–N–U, phase diagram and stability of, 18: 33576
Nb–N, equilibrium in, 18: 34177
N–U, phase diagrams, 18: 34035(R) (BMI-X-10053)
NOISE
production in power reactors, sources of, 18: 35155 (TID-7679(p.357-68))
use in fast-reactor measurements, 18: 35158 (TID-7679(p.469-500))
use in reactor shutdown reactivity measurements, 18: 35072 (TID-7679 (p.135-54))
NOZZLES
pumping characteristics of magnetohydrodynamic, 18: 35060(R) (ANL-6904)
NPD REACTOR
development and operation of, review, 18: 35171
NRU REACTOR
development and operation of, review, 18: 35171
NRX REACTOR
development and operation of, review, 18: 35171
NUCLEAR AIRCRAFT POWER PLANTS
heat exchanger design for, 18: 33754(P)
NUCLEAR BATTERIES
development for space power systems, status of, 18: 34001
properties and uses of, for direct conversion of energy into electricity, 18: 34500
NUCLEAR CHEMISTRY
book: *Physical Nuclear Chemistry*, in German, 18: 33676
NUCLEAR EMULSIONS
cosmic particle interactions in, secondary particle production in, 18: 34492
development of highly sensitive, by bromination of silver hydrosol in gelatin, 18: 33962
meson (μ) and proton multiple scattering in, 18: 34627
meson (π^-) reactions with, heavy fragment emission in, 18: 34811
proton reactions at 2 to 9 Bev, fragment angular correlations for, 18: 34940
proton spurious scattering at 24 Bev, 18: 33963
scanning of, statistics of, 18: 33892
NUCLEAR HEATING PLANTS
development status, 1963, 18: 35066 (STI/DOC/10/28(p.73-7))
NUCLEAR ISOMERS
lifetimes of radioelement-daughter, measurement of, 18: 34770 (NP-14115)
NUCLEAR MAGNETIC RESONANCE
analysis of high resolution spectra of, by nuclear Overhauser effect and transitory selective irradiation methods, 18: 34309
NUCLEAR MATERIALS MANAGEMENT
criticality of annular cylinders containing plutonium solutions, 18: 34494 (CEA-R-2495)
reactor fuel cycle costs, 18: 35151 (ORNL-TM-564)
role in assurance of nuclear safety, 18: 33799 (CONF-620-2)
NUCLEAR MODELS
book: *Nuclear and Radiochemistry*. Second Ed., 18: 33455
self-energy of Bogoliubov quasi-particle in superfluid, 18: 34687
NUCLEAR MODELS (COLLECTIVE)
energy level structure for $150 < A < 190$ and $228 \leq A \leq 254$ nuclei in, 2+, 18: 34760 (JINR-E-1696)
energy level symmetries for mass-40 nuclei in, 18: 34897
energy level transition probabilities in, electromagnetic, 18: 34761 (JINR-E-1703)
NUCLEAR MODELS (DROP)
fission in, theory for, 18: 34778 (UCRL-11338)
NUCLEAR MODELS (OPTICAL)
neutron elastic scattering in, 18: 34828
parameters of, s-wave transmission coefficient effects of, 18: 34866
NUCLEAR MODELS (SHELL)
compound nuclear states in, from unified nuclear reaction theory, 18: 34773 (NP-14190)
many-nucleon systems in, 18: 34826
nucleon clustering in, reduced widths for, 18: 34891
nucleon interactions in, 18: 34869
NUCLEAR PARTICLES
detection of, counting statistics for, 18: 33964
NUCLEAR PHYSICS
book: *Physical Nuclear Chemistry*, in German, 18: 33676
fine structure constants, 18: 34921
transformation matrix for isotropic harmonic oscillator eigenvectors, 18: 34807
NUCLEAR POWER
development of, review of, 18: 35178
developments in Switzerland, 18: 35082
role in U.S. Merchant Marine, 18: 35203 (NP-14139)
transformation into chemical energy, economics and technology of, 18: 33629
NUCLEAR POWER PLANTS
construction of marine, nondestructive testing in, 18: 35206
design with cooling of pump motor, 18: 35191(P)
development in Canada, review of, 18: 35171
development of d-c–to–d-c converters for nuclear-thermionic, 18: 34497(R) (NP-12888(Vol.5))
economics and design of Karachi, 18: 35183
leak detection and measurement in, 18: 35207
review, 18: 35180
thermodynamics of French, 18: 35169
turbine design for, 18: 33753
use in surface-effect ships, 18: 35215
NUCLEAR REACTIONS
analysis of (n,α), 18: 34810
analysis of, computer programs for, 18: 34752(R) (CU(PNPL)-234)
bibliography on cross sections for neutron-induced threshold, 18: 34753(R) (EANDC(E)-50(L))
book: *Kinematics of Nuclear Reactions*, 18: 34956
book: *Nuclear and Radiochemistry*. Second Ed., 18: 33455
cross sections for, fluctuations in, 18: 34893
direct interactions in heavy-ion, 18: 34856
mechanisms of nucleon-nuclei interactions at 100 to 1000 Bev, 18: 34764 (JINR-P-1678)
models for (n,α), in direct interactions, 18: 34769 (NP-14085)
Monte Carlo calculation of neutron production in proton-induced, at 0.3 to 1 Bev, 18: 34961
multinuclear transfer in, distribution of products from, 18: 34763 (JINR-P-1675)
neutron reactions (n,γ) with nuclei, relation between cross section and scattering length for, 18: 34762 (JINR-P-1671)
polarization in direct, theory of, 18: 34853
recoil studies of compound-nucleus and partial-momentum-transfer, 18: 34782 (UCRL-11563)
spin path mutual exchange in stripping, 18: 34873
theory of direct, spin-orbit effects in distorted-wave, 18: 34835
theory of direct, diffraction mechanism in, 18: 34848
theory of low-energy, 18: 34754 (HMI-B-35)
theory of rearrangement processes in, neutron tunneling in, 18: 34894
theory of, antisymmetrization of unified, 18: 34773 (NP-14190)
NUCLEAR SPIN
polarization in semiconductor lattice near paramagnetic impurities, r-f

suppression of, 18: 34334
NUCLEAR STRUCTURE
deformation calculations for, near N = 18, 18: 34781 (UCRL-11376)
energy level structure for 150 < A < 190 and 228 ≤ A ≤ 254, collective, 18: 34760 (JINR-E-1696)
energy levels from Coulomb excitation, gamma emission from, 18: 34965
energy levels in, delayed-coincidence measurements of lifetimes of first-excited, 18: 34772 (NP-14184)
nucleon cluster reduced widths for, 18: 34891
nucleon pairing hamiltonian in, symmetry properties of, 18: 34890
NUCLEAR THEORY
boundary-value problems in, solutions to ordinary second-order nonlinear differential equations for, 18: 34269 (JINR-P-1682)
compound nuclear states in, antisymmetrized shell-model description of, 18: 34773 (NP-14190)
fluctuations in nuclear cross sections, 18: 34893
form factors for medium and heavy nuclei, 18: 34928
moments of inertia and simplified wave functions for nuclei, 18: 34927
of low-energy reactions, 18: 34754 (HMI-B-35)
pairing correlations in excited nuclei with specified angular momentum, 18: 34930
probabilities of electromagnetic transitions from collective to ground states of even-even strongly deformed nuclei, 18: 34761 (JINR-E-1703)
symmetry properties of Nogami's modified pairing hamiltonian, 18: 34890
NUCLEI
absorption potential for, radial distribution of, 18: 34854
alpha elastic scattering by light, exchange contribution to, 18: 34801
alpha scattering by, multiparametric modular circuitry for detection of, 18: 33936
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
beta transitions ($0^+ \rightarrow 0^-$) in, 18: 34808
binding energies of, relations for, 18: 34812
bremsstrahlung excitation of, resonance fluorescence from, 18: 34852
collective g-factor for strong deformed, formula for, 18: 34939
deuteron reactions (d,xγ), spin path mutual exchange in, 18: 34873
deuteron stripping reactions with, polarization in, 18: 34853
elementary particle reactions with, book on, 18: 34956
energy level structure for 150 < A < 190 and 228 ≤ A ≤ 254, collective, 18: 34760 (JINR-E-1696)
energy levels in deformed even-even, rotational bands of two-quasi-particle, 18: 34907
energy levels in, with specified angular momentum and pairing correlations, 18: 34930
energy levels of even-even, vibrational, 18: 34933
energy levels of even-even deformed, electromagnetic transitions of collective, 18: 34761 (JINR-E-1703)
energy levels of even-even, measurement of lifetimes of first-excited, 18: 34772 (NP-14184)
energy levels of, potential shape dependence of lower, 18: 34906
energy levels of, approximations for low, 18: 34959
energy levels of, particle fluctuations in pairing wave functions for, 18: 34839
energy levels populated by Coulomb excitation in, angular distribution of gamma rays from, 18: 34965
form factors for heavy and medium, 18: 34928
gamma absorption by nucleon pairs in heavy, total cross section for, 18: 34925
gamma emission in $0^+ - 0^+$ transitions in, double, 18: 34752(R) (CU(PNPL)-234)
gamma reactions (γ,n) with (50 < A < 200), 18: 34935
gamma scattering by, Z dependence of Rayleigh, 18: 34417
meson (π^-) reactions with, heavy fragment emission in, 18: 34811
model for light, 18: 34833
moments of inertia and wave functions for, with pairing interaction, 18: 34927
neutrino pair emission by excited, 18: 34932
neutron binding energies for A = 91 to 209, 18: 34966
neutron elastic scattering at 1 Mev, optical model analysis of, 18: 34828
neutron reactions (n,α) at 14 Mev, total cross sections for, 18: 34887
neutron reactions with, bibliography on cross sections for, 18: 34753(R) (EANDC(E)-50(L))
neutron reactions (n,γ) with, relation between cross section and scattering length for, 18: 34762 (JINR-P-1671)
neutron removal cross sections for, 18: 34888
neutron scattering by, effect of non-axially symmetric deformation on thermal, 18: 34787
neutron-proton interaction in, 18: 34915
nucleon inelastic scattering by deformed, in collective model, 18: 34865
nucleon pairing hamiltonian for, symmetry properties of, 18: 34890
nucleon reactions with complex, cross sections and energy conservation for, 18: 34952
nucleon reactions at 100 to 1000 Bev, mechanisms of, 18: 34764 (JINR-P-1678)
nucleon 4-body interactions in, single-shell, 18: 34863
photon reactions with, effect of quadrupole collective motions on dipole resonance in, 18: 34908
polarization at low temperatures, dynamic, 18: 34717
properties of light, calculation of, 18: 34807
proton decay of Z > 50, 18: 34767 (JINR-P-1706)
reactions in nuclear emulsions, radii for, 18: 34964
reactions with nuclei, neutron tunneling in Coulomb field in, 18: 34894
structure of deformed, in region of N = 18, 18: 34781 (UCRL-11376)
superfluidity in, 18: 34864
transitions in light, ΔT = 0, 18: 34858
NUCLEI (CELLS)
effects of ozone on mouse and rabbit myocardial, 18: 33334
radiation effects on nuclei of mouse liver cells, x, 18: 33350
NUCLEIC ACIDS
chromosome aberrations induced in mice by, comparison of radiation with, 18: 33309
radiation effects on synthesis of, in rat spleen, 18: 33382
radiosensitivity effects of content of, on bacteria, 18: 33310
NUCLEONS
binding energies in hypernuclei, 18: 34857
emission in meson (π^-) capture by nuclei, correlations from, 18: 34851
gamma absorption by pairs of nuclear, 18: 34925
interaction of four, in same shell, 18: 34863
interaction resonances of, review on, 18: 34636
interactions in deformed nuclei, vibrational-rotational, 18: 34950
interactions in four-body systems at low energies, 18: 34619
interactions of, potentials for meson resonances in, 18: 34539
interactions of, shell-model, 18: 34869
interactions with mesons (π), relativistic corrections to s- and p-wave, 18: 34507 (JINR-E-1686)
interactions with mesons (π), secondary-particle production in, 18: 34509 (NP-14086)
interactions with mesons (π), complex singularities in amplitude for, 18: 34524
interactions with deuterons, amplitudes for break-up, 18: 34535
interactions with nucleons, singlet-state phase shifts for, 18: 34546
interactions with mesons (π), maximum coupling constant for, 18: 34548
interactions with pseudoscalar mesons, fermion Regge trajectories for, 18: 34558
interactions with neutrinos, conserved vector current testing by, 18: 34561
interactions with mesons ($\bar{K}^0$), assuming Y_1^1 Regge particle, 18: 34571
interactions with mesons (π) below 500 Mev, analysis of, 18: 34604
interactions with mesons (π), meson ($\bar{P}$) contribution to, 18: 34611
interactions with deuterons, optical theorem for, 18: 34618
interactions with tritons, amplitudes for, 18: 34619
interactions with mesons (π) at low energies, phase shifts in, 18: 34621
interactions with mesons (π), mesons (ω^0) and (ρ) production in, 18: 34622
interactions with nucleons, baryon production analysis of, 18: 34632
meson (μ) capture by, pseudoscalar coupling magnitude in, 18: 34551
pairing correlations in excited nuclei, 18: 34930
pairing in nuclei, symmetry properties of hamiltonian for, 18: 34890
reactions with complex nuclei, cross sections and energy conservation for, 18: 34952
reactions with nuclei at 100 to 1000 Bev, mechanisms of, 18: 34764 (JINR-P-1678)
scattering by deformed nuclei, inelastic, 18: 34865
spin-orbit potentials for, triplet-even, 18: 34931
systems of, in shell-model potential with residual pairing forces, 18: 34826
NUCLEOTIDES
biological properties of, 18: 33222
developmental effects on sea urchin adenosine, 18: 33270(R) (NIRS-2(p.23-6))

O

OILS
analysis for sulfur by x-ray absorption, instrument for, 18: 33472(T) (AEC-tr-6399(p.98-114))
OLEIC ACID
radiation and oxygen effects on role of oxidation products of, in yeasts, 18: 33390
OPTICAL SYSTEMS
lens design for, development of computer program for, 18: 35245 (LADC-6205)

ORES
analysis for sulfur-32 ratio with sulfur-34 in, 18: 33501
processing, automatization of crushing and classification cycle using radioisotopes, 18: 33988(T) (AEC-tr-6399(p.227-42))
ORGANIC CHEMISTRY
book: *Advances in Catalysis and Related Subjects*, 18: 33453
ORGANIC COMPOUNDS
analysis for active hydrogen by NMR spectroscopy, 18: 33475
analysis for deuterium by deuteron reactions (d,n) with carbon-12 after neutron activation, 18: 33486
analysis for sulfur and zirconium simultaneously, amperometric, 18: 33514
electron spin resonance spectra of oriented radicals in irradiated, 18: 33630
radiolysis of liquid, thermal spike model for, 18: 35247(R) (NAA-SR-9700)
synthesis of labeled, 18: 33631
ORGANIC COOLED REACTORS
design feasibility of heavy-water-moderated, up to 8300 Mw(th), 18: 35143(R) (DP-915)
development for electric power production in Canada, 18: 35173
review and survey of power, 18: 35161 (TID-8540(p.71-129))
ORGANIC MODERATED REACTORS
review and survey of power, 18: 35161 (TID-8540(p.71-129))
ORGANISMS
radioisotope uptake by marine, 18: 33230
OSCILLATORS
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
OSMIUM
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
OSMIUM CARBIDES
preparation of, conditions for, 18: 33572
OSMIUM ISOTOPES Os-186
energy levels of, vibration-rotation interactions in, 18: 34846
spin of, Coriolis anti-pairing and blocking effects on, 18: 34775 (TID-20875)
OSMIUM ISOTOPES Os-188
energy levels of, vibration-rotation interactions in, 18: 34846
spin of, Coriolis anti-pairing and blocking effects on, 18: 34775 (TID-20875)
OSMIUM ISOTOPES Os-190
spin of, Coriolis anti-pairing and blocking effects on, 18: 34775 (TID-20875)
OXALACETATES
decarboxylation of rare earth, carbon-13 isotope effects on, 18: 33598
OXALACETIC ACID
decarboxylation of, carbon-13 isotope effects on, 18: 33598
OXALIC ACID
reactions with cerium in sulfuric acid media, effects of sodium sulfates on, 18: 33537
OXETANES
3,3-*bis*-chloromethyl-, catalytic effects of solid additives on radioinduced polymerization of solid, 18: 33651
OXIDATION
reaction mechanisms in, analysis of tracer techniques in studies on, 18: 33985
OXYGEN
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
determination in argon in gas chromatography, electron drift velocity detector for, 18: 33476
determination in gallium arsenide, activation, 18: 33541
determination in MSRE fuel salts, 18: 34050(R) (ORNL-3626(p.59-164))
determination in metals, vacuum fusion, 18: 33491
determination in refractory metals, review of methods for, 18: 33515
determination in refractory metals, review of methods for, 18: 33516
determination in sodium, 18: 33678(R) (ANL-6875)
determination in sodium in test loop, 18: 35060(R) (ANL-6904)
effects on radiation damage in silicon crystals, 18: 34228
effects on radiolysis of liquid methanol, 18: 33618 (CONF-322-14)
effects on radiosensitivity of tumor cells in mice, 18: 33379
effects on radiosensitivity of animal tissues, 18: 33404
effects on role of oleic acid oxidation products in yeasts, 18: 33390
effects on tensile properties of wrought niobium and tantalum, 18: 34196
effects on uranium corrosion by water, 18: 34072 (AWRE-O-40/64)
effects on vacuum gage operation, anomalous, 18: 33759 (AD-427830)
meson (π) scattering at 80 Mev, high-energy approximation, 18: 34911
potential energy curves, 18: 34281 (RM-4034-PR)
radiosensitivity effects on bacteria, gamma, 18: 33326
radiosensitivity effects on rats, 18: 33365
reactions with ionic, calculations of charge exchange and charge exchange and diffusion cross sections for, 18: 34418
reactions with uranium nitride at 300 to 450°C, kinetics, 18: 34035(R) (BMI-X-10053)
solubility in niobium, 18: 34177
OXYGEN IONS
potential energy curves for molecular, 18: 34281 (RM-4034-PR)
reactions with oxygen, calculations of charge exchange and charge exchange and diffusion cross sections for, 18: 34418
recombination of diatomic positive, with electrons, 18: 34259 (AD-434907)
OXYGEN ISOTOPES
biological effects of, nuclear-man, 18: 33258
fractionation between calcite, quartz, and magnetite for geothermometry, 18: 33785
ratios in glass, soils, and tektites, 18: 33787
use in geology of dolomites, 18: 33786
OXYGEN ISOTOPES O-15
reactions (O-15,O-16) with rhodium at 10 Mev, differential cross sections for, 18: 34951
OXYGEN ISOTOPES O-16
alpha reactions (α,d) at 45 to 50 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
alpha reactions (α,γ) at 4.8 to 9.9 Mev, 18: 34829
carbon-12 inelastic scattering by, distorted-wave approximation for, 18: 34774 (ORNL-P-144)
deuteron elastic scattering at 8.0 to 10.5 Mev, analyses of, 18: 34758 (JEN-130-DF/I-41)
deuteron reactions (d,α) and (d,p) at 0.8 and 1.7 Mev, 18: 34860
energy level population in (α,d) reactions, 18: 34779 (UCRL-11341)
energy levels of, 2^+ T = 0, 18: 34814
energy levels of, in particle-hole model, 18: 34824
gamma absorption in, quasi-deuteron production in, 18: 34926
helium reactions (He-3,p) at 13.9 and 31.2 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
meson (π^-) capture by, nucleon correlations from, 18: 34851
neutron reactions (n,α) with, angular distribution for, 18: 34876
neutron reactions (n,α) at 14 Mev, direct-interaction model for, 18: 34769 (NP-14085)
neutron reactions (n,d) at 14 Mev, distorted-wave approximation for, 18: 34774 (ORNL-P-144)
nuclear structure of, alpha cluster reduced widths for, 18: 34891
reactions (O-16,F-18) with rhodium at 160 Mev, differential cross sections for, 18: 34951
reactions (O-16,O-15) with rhodium at 10 Mev, differential cross sections for, 18: 34951
reactions with bismuth, iridium, and lead-208 at 75 to 165 Mev, recoil studies for, 18: 34782 (UCRL-11563)
reactions with nuclei at 167 Mev, charged-particle emission in, 18: 34780 (UCRL-11349)
reactions with scandium-45 at 20 to 80 Mev, production of scandium-44 isomer pairs in, 18: 34948
scattering by nuclei, diffraction mechanism for elastic, 18: 34848
OXYGEN ISOTOPES O-17
energy level population in (α,d) reactions, 18: 34779 (UCRL-11341)
OXYGEN ISOTOPES O-18
energy levels, 18: 34869
exchange reactions with molybdenum and tungsten oxides, mechanism of, 18: 33545
isotope effects on molecular dipole moments of carbon dioxide, 18: 33597
tracer uses in biochemistry, 18: 33257
OXYGEN ISOTOPES O-20
energy levels, 18: 34869
OXYGEN SYSTEMS
Nb–O, superconducting critical fields in, 18: 34704
Nb–O–Zr, phase studies on, 18: 34211
O–Zr, electron energy bands in crystals of, 18: 33543
OYSTER CREEK POWER REACTOR
economic comparison with CANDU Reactor, 18: 35172
OZONE
effects on human chromosomes, 18: 33334
toxicity of, radiomimetic, 18: 33334

P

PACIFIC OCEAN
calcium/strontium ratios in marine biota, 18: 33259
radioactivity during 1959–1960, 18: 33779
PAINTS
radiation effects on, 18: 33839 (RTD-TDR-63-4287(Vol.II))
radiation effects on, handbook on, 18: 34245

PAIR PRODUCTION
cross sections for direct electron–positron, by fast electrons, 18: 34258(R) (AD-417250)
electron, in photon reactions with hydrogen atoms, 18: 34439
PAKISTAN
nuclear power for, 18: 35257
PALLADIUM
gadolinium EPR in, g-shifts in, 18: 33587
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
properties at high temperatures, 18: 34029(R) (AD-601740)
spectra of, x-ray L-absorption and -emission, 18: 34412
PALLADIUM ALLOYS
Pd–Pt, corrosion by air and nitrogen at 2550°F, 18: 34029(R) (AD-601740)
Pd–Pt, diffusion in FS-85 and TZM alloys, 18: 34029(R) (AD-601740)
Pd–U, gadolinium EPR in, 18: 33587
PANCREAS
representation of, by external counting, 18: 33442
PARAFFIN
paraffin-S, radiation effects on polarization of, 18: 33622
PARAMECIUM
radiosensitivity of conjugating, 18: 33273(R) (NIRS-2(p.42-8))
PARASITES
liver infestations by tracer diagnostic methods for, 18: 33214 (STI/DOC/10-28(p.105-11))
radiation effects on *Toxoplasma gondii*, 18: 33331
radiation effects on human, *in utero* exposure, 18: 33391
PARATHYROID HORMONES
strontium-85 removal from bones using, 18: 33231(R) (NIRS-2(p.49-56))
PARTICLE STATISTICS
computer methods for few-particle experiments in, 18: 34663
quantum, of degenerate boson system, 18: 34337
quantum, of degenerate boson system, lambda transformation in, 18: 34338
quantum, of degenerate boson system, 18: 34339
PARTICLE TRACKS
gap density distribution of, measuring system for, 18: 33971
measurement in bubble chambers, projector for, 18: 33957
production in streamer chambers, mechanisms for, 18: 33965
PARTICLES
detection and measurement of, performance of counters for, 18: 33899
dispersion in atmospheric aerosols, 18: 33806(R) (NYO-10715)
electric charge collection by, in ionized medium, 18: 34314
impaction of, on bodies under high-altitude conditions, 18: 33806(R) (NYO-10715)
reactions in flow of gas-particle mixtures, 18: 33749
PATHOLOGY
of ionizing radiation, 18: 33396
of radiation effects on carcinomatous and normal tissue, 18: 33296
radiation effects on fish intestinal epithelium, x, 18: 33272(R) (NIRS-2(p.31-42))
radiobiology in, survey, 18: 33397
review of experimental, 18: 33229
PEACH BOTTOM POWER REACTOR
fuel element development for, economics of graphite, 18: 35176
PEAS
radiation effects on DNA in, gamma, 18: 33356
strontium-90 uptake by, effects of calcium, potassium, and sodium on, 18: 33241
PEBBLE BED REACTORS
catalog of concepts for, 18: 35119 (ANL-6892)
2,4-PENTANEDIONE COMPLEXES
with terbium, quenching and temperature dependence of fluorescence in, 18: 33556
2,4-PENTANEDIONE, HEXAFLUORO-
complexes with europium, quenching and temperature dependence of fluorescence in, 18: 33556
PENTANES
radiolysis of hydrogen in deuterated, proton transfer reactions of H_3^+ in, 18: 33639
2-PENTANONE, 4-METHYL-
radiolysis, effects of uranyl nitrate and water on gamma, 18: 33621 (UJV-977/64)
4-methyl-2-pentanone–TBP, solvent properties for uranium from aqueous solutions, 18: 33679 (JEN-136-DQ/I-40)
1-PENTENE
yields in gamma radiolysis of liquid cyclohexanone, 18: 33623
PEPTIDES
chromatographic separation of, from ovalbumin, 18: 33499
PERCHLORIC ACID
effects on ion exchange properties of titanium and zirconium salts, 18: 33535
PEROXIDES
effects on protein thiol groups, 18: 33236(T) (ANL-Trans-54)
PERSONNEL
cancer mortality among mining, 18: 33813
design of monitor for detection of gross beta-gamma hand and foot contamination on, 18: 33877 (DP-893)
radiation dose to medical, from iodine-131 thyrotoxicosis therapy, 18: 33421
radiation dosimetry of AB Atomenergi, 18: 33798(R) (AE-147)
radiation dosimetry at Risø, 18: 33807 (RISO-78)
radiation protection of female, handling radioactive materials, 18: 33395
radium measurement in industrial, 18: 33424
PERTURBATION THEORY
Brillouin-Wigner, derivation from Schrödinger equation, 18: 34024
fermion Regge trajectories for nucleon-pseudoscalar meson interactions in, 18: 34558
formalism for electromagnetic wave diffraction by dielectrics, 18: 34346
formalism for ground state of many-fermion systems, 18: 34559
formalism for radial distribution function in classical thermodynamics, 18: 34344
time-dependent, for Hartree-Fock wave function of atomic molecular systems, 18: 34426
PETROLEUM
heat treatment of aromatic catalytic cycle stock extract for increased stability, 18: 33616(P)
origin and evolution mechanisms, carbon isotope studies, 18: 33783
PHANTOMS
use in computer analyses of radiation hazards in space flight, 18: 35048 (AMRL-TDR-64-11)
PHASE STUDIES
of refractory metal alloys from thermochemical data, 18: 33603
PHENOL
phenol–H_2O, compound formation in, 18: 34131 (TID-20849)
PHENOL, DINITRO-
radiosensitivity effects in toad embryos, x, 18: 33272(R) (NIRS-2(p.31-42))
PHENOTHIAZINE, 2-CHLORO-10-(3-DIMETHYLAMINOPROPYL)–
effects on radiation effects on acetylcholine and sympathin content in rat brain, 18: 33325
PHONONS
interactions of long-wavelength, with electrons, 18: 34454
interactions with electrons, theory for, 18: 34453
interactions with electrons in superconductors, 18: 34708
interactions with electrons in superconductivity, 18: 34722
PHOSPHATES
5-ribosyluracil-5'-, synthesis by *Tetrahymena pyriformis*, 18: 33246
PHOSPHATIDES
content and metabolism in irradiated and normal rat testes, effects of ACTH and cortisone on, 18: 33256
determination of, in fatty livers from rats, 18: 33493
PHOSPHINE OXIDE, TRIBUTYL-
solvent properties for metallic ions, 18: 33685
PHOSPHINE OXIDE, TRIOCTYL-
solvent properties for metallic ions, 18: 33685
solvent properties for americium, curium, and europium, 18: 33686
PHOSPHORESCENCE
decay time of, device for measuring, 18: 33637
PHOSPHORS
development of liquid, for detection of antineutrino reactions, 18: 33901
development of liquid, for carbon-14 and tritium detection, 18: 34274(R) (NIRS-2(p.3-15))
development of NaI(Tl)-plastic, for gamma delayed-coincidence measurements, 18: 34772 (NP-14184)
performance of liquid, for discriminating gamma rays from neutrons, 18: 34752(R) (CU(PNPL)-234)
preparation of, for thermoluminescent dosimeter, 18: 33981(P)
properties of plastic, for use in counter telescopes, 18: 33889(T) (NASA-TT-F-126(p.161-76))
radioinduced scintillation output from, alpha and gamma, 18: 33638
response of Pilot B, to electrons at 0.6 to 1 Mev, 18: 33902
scintillation processes in alkali halide crystal, 18: 33636
PHOSPHORUS
content in soil, availability for plants, 18: 33213 (STI/DOC/10/28(p.79-103))
contents in meteorites, 18: 34398
determination in silicon, activation, 18: 33502
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R)

(NIRS-2(p.3-15))
PHOSPHORUS CHLORIDES
chemistry of P_2Cl_4, 18: 35254 (UCRL-11189)
PHOSPHORUS ISOTOPES P-30
positron spectra, 18: 34783(T) (ORNL-tr-235)
PHOSPHORUS ISOTOPES P-31
electrodeposition on p-type silicon, 18: 34005(R) (ORNL-TM-879)
energy level at 450 kev, 18: 34818
neutron reactions (n,α) with, 18: 34799
production in neutron reactions (n,γ) in silicon semiconductors, 18: 33920
proton reactions (p,γ) with, 18: 34924
PHOSPHORUS ISOTOPES P-32
beta decay of, internal bremsstrahlung from, 18: 34837
beta particles from, polarization of, 18: 34877
determination in urine, 18: 33518
differential uptake of, by esophagus cancers, diagnostic use of, 18: 33438
incorporation in DNA of cells for life-cycle measurement, 18: 33226
metabolism of, by fish, 18: 35238 (STI/DOC/10/28(p.9-20))
PHOTOCHEMISTRY
of uranyl nitrate sensitized tetrabutylammonium iodide, formation of tributyliodoammonium iodide in, 18: 33628
quantum conversion in chloroplasts, 18: 33218
PHOTOELECTRIC CELLS
development for space power systems, status of, 18: 34001
development of promethium-147 betavoltaic, 18: 34034(R) (BMI-1672(Del.))
PHOTOGRAPHIC FILM
scanning of, equipment for, 18: 33971
PHOTOGRAPHIC FILM DETECTORS
design and performance of pulse amplitude spectrometer using, 18: 33893
performance of gamma and neutron, 18: 33807 (RISO-78)
PHOTOMETRY
development of technique for cytological studies, 18: 33234 (UCRL-11459)
PHOTOMULTIPLIER TUBES
design of regulated dynode PM heads, 18: 34752(R) (CU(PNPL)-234)
development, 18: 33903
development, 18: 33907
development, 18: 33908
development for uv and x radiations, 18: 33904
development for uv radiation, 18: 33905
development of 5-inch, 14-stage, high-speed, 18: 33882(R) (NYO-3190-1)
electron field emission of, effects of time-dependent, 18: 33910
electron secondary emission statistics for windowless, 18: 33911
electron transit times in, uses for, 18: 33961
PHOTON BEAMS
phase-space occupation of, 18: 34641
PHOTONS
absorption by sodium vapor at 1000 to 2400 Å, cross sections for, 18: 34443
boson character of, 18: 34641
interactions with protons, hyperon (Λ) and meson (K^+) production in, 18: 34536
interactions with zero-spin particles at low energies, field theory for, 18: 34538
interactions with protons, hyperon (Σ) production in, 18: 34566
interactions with protons at 1280 Mev, hyperon (Σ^+) production in, 18: 34591
interactions with nucleons, vector meson production in, 18: 34620
reactions (γ,e) with atoms, angular distributions for, 18: 34847
reactions and scattering of, theory of, 18: 34624
reactions with hydrogen atoms, recoil distribution from electron pair production in, 18: 34439
reactions with nuclei, dipole resonance in, 18: 34908
scattering by helium, neutron polarizability from, 18: 34538
PHYSICS
cluster and product properties of sequences of symmetric functions, 18: 34313
Green function theory in solid-state, 18: 34648
self-avoiding walks on integral points in Euclidean space, number of, 18: 34312
PHYSOSTIGMINE
protective effects against radiation effects in rats, 18: 33306
PIEZOELECTRIC CRYSTALS
radiation and environmental effects in space, 18: 34235
PIGMENTS
radiation effects on production of fish, 18: 33272(R) (NIRS-2(p.31-42))
radioinduced expansion of melanophore, in hypophysectomized frogs, 18: 33277 (STI/DOC/10/28(p.21-38))
PINCH DEVICES
development of Chalice cusp-containment, 18: 34978(R) (SIT-P126)
PINCH EFFECT
light scattering by theta, spectral distributions of, 18: 35010
theory of transient, similarity solutions in MHD, 18: 34997
PIPERIDINE
complexes with europium benzoylacetonate, ligand field spectra of, 18: 33565
complexes with europium, quenching and temperature dependence of fluorescence in, 18: 33556
PIPES
burnout detection in, radiometric instrument for, 18: 33846(T) (AEC-tr-6399(p.30-42))
elastic properties of stainless steel, at high temperatures, 18: 34175
water flow in, pressure drop in boiling, 18: 33745
PIQUA POWER REACTOR
fuel elements for, equipment for evaluation of irradiated, 18: 35247(R) (NAA-SR-9700)
PITUITARY GLAND
metabolism of thyroid hormones in, 18: 33278 (STI/DOC/10/28(p.39-66))
radiation effects on fish skin melanization by, x, 18: 33272(R) (NIRS-2 (p.31-42))
PLANKTON
fission product metabolism in, 18: 35238 (STI/DOC/10/28(p.9-20))
PLANT CELLS
radiation recovery in, statistical model for, 18: 33355
PLANT RESPIRATION
radiation effects on, in pine trees, 18: 33315
PLANTS
cesium-137 and strontium-90 uptake by Japanese, 18: 33805(R) (NIRS-2(p.57-67))
cesium-137 uptake by, from soil and irrigation water, 18: 33239
radiation and mutagen-induced mutations in *Vicia faba*, x, 18: 33303
radiation effects on physiological state of, 18: 33284(T) (AEC-tr-5836)
radiation effects on genetics of Tradescantia, cosmic, 18: 33354
radioinduced mutations in agricultural crop, 18: 33213 (STI/DOC/10/28 (p.79-103))
radioinduced mutations in carnation, gamma, 18: 33302
radioinduced mutations in asparagus, fast-neutron, 18: 33323
radioinduced mutations in *Phaseolus mungo*, x, 18: 33324
strontium content at Warsaw, 18: 33778
strontium-90 and cesium-137 uptake by above-ground parts of, from air, 18: 33235(T) (AEC-tr-6448)
strontium-90 uptake by, from soil and irrigation water, 18: 33239
PLASMA
accelerator for, surface effects in pulsed, 18: 34980
burnout in steady-state, 18: 35014
charged-particle energy losses in, 18: 34996
collective description of classical, 18: 34972 (ARL-64-140)
containment device for, with reversed magnetic field, 18: 34993
containment in cusp-geometry, system for, 18: 35047(P)
diagnostics of afterglow, Langmuir probe techniques for, 18: 34999
diagnostics of theta-pinch, using infrared maser radiation, 18: 35013
diagnostics of, controlled-mode technique for microwave, 18: 35041
diagnostics of, microwave techniques for, 18: 35020
dielectric constant of, equations for, 18: 35036
diffusion in ionospheric geomagnetic fields, 18: 34678
distribution functions of, in thermodynamic equilibrium, 18: 34415
effects on horn antenna radiation pattern, 18: 34968 (AFCRL-64-18)
effects on powdered rock, 18: 34392
electric conductivity of quantum, in uniform magnetic field, 18: 34985
electric conductivity of, neutral particle effects on high-frequency, 18: 34992
electric conductivity of, method for measuring, 18: 35000
electric conductivity of, measurement of, 18: 35001
electric conductivity of, equations for, 18: 35036
electric field interactions in inhomogeneous, nonlinear effects in, 18: 35024
electromagnetic wave propagation in, collision effects in, 18: 35038
electromagnetic wave interactions in, longitudinal and transverse, 18: 35025
electron beam interactions in, instabilities from, 18: 35011
electron cyclotron resonance in, nonlinear theory of cyclotron, 18: 34988
electron cyclotron resonance in, in Fermi-liquid theory, 18: 35045
electron density changes in, interferometer for detecting, 18: 35022
electron density fluctuations in, temperature dependence of, 18: 34981
electron density measurements for, impedance condenser probe for, 18: 34969 (AFCRL-64-247)
electron temperatures in unstable, double-probe method for, 18: 35021
electrostatic wave damping in, Landau, 18: 35016

flow over conducting surfaces in magnetic fields, boundary conditions for, 18: 35005
heat transfer from, channel, 18: 33752
heat transfer in completely ionized nonisothermal, in motion across magnetic field, 18: 35026
hydromagnetic wave coupling to acoustic and electromagnetic waves at gas interface with, 18: 35004
interactions with electromagnetic waves, model for, 18: 34970 (AFCRL-64-250)
kinetic equation for homogeneous, in uniform magnetic field, 18: 35037
kinetic equation for inhomogeneous unstable, 18: 34995
kinetics in magnetic fields, book on, 18: 35028
kinetics of, equations for, 18: 35029
kinetics of, master equation for, 18: 35046
kinetics of, MGD equations for, 18: 35034
laser beam scattering by, produced by gas breakdown, 18: 34348
light scattering by theta-pinch, spectral distributions of, 18: 35010
magnetic fields from conical current sheets in, Legendre polynomial evaluation of, 18: 34273 (NASA-TN-D-2400)
magnetic flux transport by shock-produced, 18: 35007
magnetohydrodynamic shock in interplanetary, 18: 34393
microwave emission by cylindrical, 18: 34986
microwave interactions in afterglow, from cryogenic gas, 18: 35015
oscillations at ion-cyclotron resonance, damping of transverse, 18: 34974 (NP-14153)
oscillations in magneto-, instabilities of electron Langmuir, 18: 34989
oscillations in, extended random-phase approximation, 18: 35002
oscillations in, Landau damping of, 18: 35033
oscillations of, collective, 18: 34982
oscillations of, nonlinear effects in unstable, 18: 34523
particle flux and temperature in, 18: 35027
particle interactions in, theoretical analysis of, 18: 34978(R) (SIT-P126)
pinch discharges in, similarity solutions for transient, 18: 34997
production by electron beams in diodes, 18: 35044
production by laser beam on metal foils, 18: 35039
radio wave propagation across velocity discontinuity in, 18: 34991
shock propagation in, MHD, 18: 35006
shock propagation in, theory for, 18: 35032
shock structure in, 18: 34998
spectra of, radiative transfer for Doppler-broadened resonance lines in, 18: 35019
spectroscopy of, rapid scanning spectrograph for, 18: 34983
spectrum of neon VII and VIII in, 18: 34384
stability in magnetic mirror systems, analysis of, 18: 34979 (UCRL-11077)
stability in magnetic fields, computer programs for analysis of, 18: 34266 (CLM-R-31)
stability of dissipative homogeneous, gravitational, 18: 34990
stability of transverse waves in, 18: 34994
stability of, compressibility effects on Kelvin–Helmholtz, 18: 35003
stability of, theory for, 18: 35031
statistical mechanics, 18: 34971 (ARL-64-85)
temperature and velocity of, in crossed electric and magnetic fields, 18: 34987
thermal equilibrium in shock-heated, 18: 35042
transport equations for partially ionized, in strong magnetic field, 18: 35018
trapping magnetosphere, simulation of, 18: 34984
ultraviolet emission from helium at 584 Å, 18: 35012
uses in microwave circuits, 18: 34977(R) (RADC-TDR-64-94)
wave interactions in, nonlinear excitation of hydromagnetic waves and hybrid resonances in, 18: 34967 (AFCRL-63-786)
wave propagation in, theory of, 18: 35030
wave resonance in hot nonuniform positive-column, 18: 34976 (NP-14195)
wave resonances in hot nonuniform positive-column, 18: 34975 (NP-14194)

PLASMA JETS
configuration in curved magnetic fields, 18: 35023
particle losses in curved magnetic fields, 18: 35023
turbulence in, magnetic probe observation of, 18: 35040

PLASTIC COATINGS
performance of two-component epoxy, for storing thorium residues, 18: 35246(R) (MLM-1196)

PLASTIC FILMS
radiation effects on, handbook on, 18: 34245

PLASTICS
radiation and environmental effects in space, 18: 34235
radiation effects on encapsulating, potting, and structural, handbook on, 18: 34245

PLATES
free-molecule flow over moving circular, density distribution in, 18: 33742

PLATINUM
analysis for hydrogen, nitrogen, and oxygen, vacuum fusion, 18: 33491
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
corrosion by air and nitrogen at 2550°F, 18: 34029(R) (AD-601740)
determination in silicon, activation, 18: 33502
diffusion in FS-85 and TZM alloys, 18: 34029(R) (AD-601740)
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
electron reactions (e,n) at 16 Mev, neutron spectra of, 18: 34945
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
radiation effects on, recovery spectrum from electron, 18: 35247(R) (NAA-SR-9700)
surface properties for molten chloride and fluoride salts, 18: 34050(R) (ORNL-3626(p.59-164))

PLATINUM ALLOY COUPLES
Pt/Pt–Rh, thermocouple drift at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)
Pt–Rh/Pt–Rh, thermocouple drift at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)

PLATINUM ALLOYS
Pd–Pt, corrosion by air and nitrogen at 2550°F, 18: 34029(R) (AD-601740)
Pd–Pt, diffusion in FS-85 and TZM alloys, 18: 34029(R) (AD-601740)

PLATINUM CATALYSTS
C–Pt, poisoning by hydrogen during isotopic exchange in water, 18: 33527 (IFA-28-IS)

PLATINUM COUPLES
Pt/Pt–Rh, thermocouple drift at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)

PLATINUM ISOTOPES Pt-192
energy levels of, measurement of lifetime of first excited, 18: 34772 (NP-14184)

PLATINUM ISOTOPES Pt-197
decay of isomeric, 18: 34879

PLOWSHARE PROJECT
uses of, future, 18: 35178

PLUTONIUM
brittleness of alpha-, 18: 34198
determination in irradiated fuel elements, alpha spectroscopic, 18: 35065 (STI/DOC/10/28(p.67-71))
determination in urine, radiochemical, 18: 33677
determination in urine, 18: 33518
diffusion of delta-phase, at 350 to 440°C, coefficient for self-, 18: 34191
electric conductivity at 300°K, reduced Ziman, 18: 34164
electric conductivity, anomalous, 18: 34280(R) (NYO-2680-1)
electrodeposition on platinum, 18: 34007(R) (ORNL-TM-890)
excretion of, in urine, 18: 33267
hydridation of, for preparation of nitride, 18: 34034(R) (BMI-1672(Del.))
losses by evaporation during reprocessing of fuel elements, 18: 35247(R) (NAA-SR-9700)
metabolism in man, mathematical model for, 18: 33267
metabolism of, effects of chemical form on, 18: 33328
oxidation and ignition, 18: 33678(R) (ANL-6875)
processing of, radiobiological aspects of, 18: 33420
recycle development, 18: 35060(R) (ANL-6904)
separation by anion exchange, accident during, 18: 33809(T) (HW-tr-78)

PLUTONIUM ALLOYS
phase diagrams and properties, literature survey, 18: 34125 (KFK-220)
Cd–Pu, phase studies and thermodynamic properties, 18: 33678(R) (ANL-6875)
Np–Pu, structure of single crystal of, 18: 34171
Pu–U, burnup and recycling in light-water-moderated reactors, 18: 35128(R) (GEAP-4642)

PLUTONIUM CARBIDES
PuC–UC, preparation, 18: 33678(R) (ANL-6875)
PuC–UC, radiation effects on, 18: 34032(R) (BMI-1668(Del.))
PuC–UC, radiation effects on, 18: 34033(R) (BMI-1669(Del.))
PuC–UC, radiation effects on, 18: 34034(R) (BMI-1672(Del.))

PLUTONIUM(III) CHLORIDES
$PuCl_3$–KCl–NaCl, phase studies and properties as reactor fuels, 18: 34050(R) (ORNL-3626(p.59-164))

PLUTONIUM COMPLEXES
with bromide and chloride in solutions, spectrophotometric and ion exchange studies, 18: 33526 (IA-924)

PLUTONIUM FLUORIDES
radiation chemistry, 18: 33678(R) (ANL-6875)
separation from contaminated exhaust air, 18: 33678(R) (ANL-6875)

PLUTONIUM(VI) FLUORIDES

crystal lattice constants, 18: 35060(R) (ANL-6904)
spectra of gaseous, absorption, 18: 33678(R) (ANL-6875)
PLUTONIUM ISOTOPES
separation of, electromagnetic, 18: 34005(R) (ORNL-TM-879)
PLUTONIUM ISOTOPES Pu-238
electron and gamma transitions in, low-energy, 18: 34798
energy levels of, vibration-rotation interactions in, 18: 34846
half life, 18: 35246(R) (MLM-1196)
nucleon vibrational-rotational interactions in, 18: 34950
properties for use as heat source in direct conversion devices, 18: 34002
separation from uranium-234 by anion exchange and solvent extraction, 18: 35246(R) (MLM-1196)
PLUTONIUM ISOTOPES Pu-239
determination in feces of, after inhalation, 18: 33266
determination of content in man and dogs, after inhalation, 18: 33260
fission of, cluster-model, 18: 34872
monitoring atmospheric, 18: 33819
PLUTONIUM ISOTOPES Pu-240
electrodeposition on nickel, 18: 34005(R) (ORNL-TM-879)
electron and gamma transitions in, low-energy, 18: 34798
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950
PLUTONIUM ISOTOPES Pu-241
neutron fission cross section of, 18: 34914
PLUTONIUM NITRATES
plutonium nitrate–uranium nitrate, reactions with ammonium hydroxide to produce (plutonium–uranium) dioxide, 18: 35146(R) (GEAP-4601)
PLUTONIUM NITRIDES
compatibility with metals and alloys, 18: 34032(R) (BMI-1668(Del.))
development, 18: 34032(R) (BMI-1668(Del.))
development, 18: 34033(R) (BMI-1669(Del.))
development, 18: 34034(R) (BMI-1672(Del.))
PLUTONIUM OXIDES
fluorination by fluidized-bed methods, 18: 33678(R) (ANL-6875)
PLUTONIUM(IV) OXIDES
fabrication and properties of sintered, effects of strontium oxide additions on, 18: 34049(R) (NUMEC-P-106)
oxidation by oxygen at high temperatures, 18: 34049(R) (NUMEC-P-106)
preparation and properties of precipitated powders of, 18: 34049(R) (NUMEC-P-106)
preparation of hydrothermally stable sols of, 18: 33609(P)
PuO_2–UO_2, compatibility with rhenium/tungsten couples, 18: 35146(R) (GEAP-4601)
PuO_2–UO_2, development and testing of fuels of, 18: 35146(R) (GEAP-4601)
PuO_2–UO_2, fabrication and properties of sintered, effects of silicon oxide additions on, 18: 34049(R) (NUMEC-P-106)
PuO_2–UO_2, oxidation by oxygen at 400 to 1400°C, 18: 34049(R) (NUMEC-P-106)
PuO_2–UO_2, phase studies, 18: 35146(R) (GEAP-4601)
PuO_2–UO_2, preparation and properties of coprecipitated powders of, 18: 34049(R) (NUMEC-P-106)
PuO_2–UO_2, preparation from mixed nitrates, 18: 35146(R) (GEAP-4601)
PuO_2–UO_2, reactivity temperature coefficients of fuels of, 18: 35114(T) (ORNL-tr-263)
PLUTONIUM RECYCLE TEST REACTOR
fuel element irradiation performance, nested tubular, 18: 35129 (HW-80291)
kinetics tests for, using random signals from moderator-level fluctuations, 18: 35111 (HW-81211)
PLUTONIUM SYSTEMS
criticality studies of solutions in annular cylinders, 18: 34494 (CEA-R-2495)
phase diagrams and properties, literature survey, 18: 34125 (KFK-220)
POLAND
strontium content of plants and soil in, 1962, 18: 33778
POLAROGRAPHY
capillary fabrication for Teflon dropping-mercury electrode, for glass-corroding solutions, 18: 33451 (ORNL-3654)
developments in d-c, at ORNL, 18: 33452 (ORNL-P-145)
POLARONS
theory, 18: 34280(R) (NYO-2680-1)
POLONIUM
removal of deposited, from mice, rats, and dogs, effects of lagochylus on, 18: 33412
POLONIUM COMPLEXES
hexahalo-, optical absorption spectra of, 18: 35246(R) (MLM-1196)
POLONIUM ISOTOPES
range-energy curves of 6- to 12-Mev recoils of, in aluminum and aluminum oxide foils, 18: 34782 (UCRL-11563)
POLONIUM ISOTOPES Po-208
decay schemes, 18: 35246(R) (MLM-1196)
POLONIUM ISOTOPES Po-209
decay schemes, 18: 35246(R) (MLM-1196)
POLONIUM ISOTOPES Po-210
determination in urine, 18: 33518
determination of internal, by radiochemical urine analysis, 18: 33519
properties for use as heat source in direct conversion devices, 18: 34002
uptake by food and human tissues, 18: 33819
POLYMERS
radiation effects on unsaturation in, 18: 34220 (TID-20787)
POLYPHENYL SYSTEMS
radiolysis of, mechanism of, 18: 33667
POLYSACCHARIDES
radiation effects on, in rat connective tissue, 18: 33277 (STI/DOC/10/28(p.21-38))
POPULATIONS
cesium-137 content in, determined by analysis of blood samples, 18: 33263
civilian defense measures for, 18: 33814
radiation protection of general, 18: 33401
radiation protection guides for general, 18: 33430
radiosensitivity of mouse, genetic factors affecting, 18: 33281(R) (TID-20844)
PORCELAIN ENAMELS
radiation effects on, 18: 33839 (RTD-TDR-63-4287(Vol.II))
POROUS MATERIALS
gas flow through, rates of, 18: 33747
POSITRONS
annihilation in calcium, magnesium, and zinc oxides, angular correlations in, 18: 33605
annihilation in diatomic and monatomic gases, 18: 34752(R) (CU(PNPL)-234)
detection of, from arsenic-74 or copper-64 deposited in brain tumors, diagnostic use of, 18: 33432
interactions with K-shell electrons, single-quantum annihilation in, 18: 34577
polarization measurements on, 18: 34752(R) (CU(PNPL)-234)
production of electron–positron pairs by fast electrons, 18: 34258(R) (AD-417250)
reactions with lead, tin, tungsten, and zirconium, ionization in, 18: 34431
POTASSIUM
catalytic effects on radioinduced polymerization of solid 3,3-*bis*-chloromethyloxatane, 18: 33651
content in mouse urine, radiosensitivity prediction by, 18: 33321
contents in meteorites, 18: 34398
effects on uptake of strontium-90 by barley and pea plants, 18: 33241
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
properties as reactor working fluid, 18: 35198 (NAA-SR-8617(Vol.I))
reactions with methyl iodide crossed beams, scattering in, 18: 33564
scattering by hydrochloric and hydriodic acid crossed beams, elastic and reactive cross sections for, 18: 33560
scattering by molecules at thermal energies, total cross sections for, 18: 34407 (UCRL-11071)
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
POTASSIUM ALLOYS
K–Na, properties as reactor working fluid, 18: 35198 (NAA-SR-8617 (Vol.I))
K–Na, thermal properties of, effects on reactor transients, 18: 35146(R) (GEAP-4601)
Sb–Cs–K, performance as photocathode, 18: 33903
POTASSIUM AZIDES
radiolysis of, electron spin resonance of potassium colloids formed in, 18: 33647
POTASSIUM BROMIDES
beta scattering by, measurement of saturated backscattering from, 18: 35057
radioinduced color centers in, mechanism of x, 18: 34280(R) (NYO-2680-1)
radioinduced defects in, kinetics of annealing of, 18: 34280(R) (NYO-2680-1)
radioinduced luminescence at 4 to 80°K, x, 18: 33648
POTASSIUM CHLORIDES
beta scattering by, measurement of saturated backscattering from, 18: 35057
crystal structure of, acoustic attenuation study of friction on fast moving dislocations in, 18: 34276 (NP-14129)

F centers in, anomalous broadening of optical absorption of, 18: 34280(R) (NYO-2680-1)
ionic conductivity of crystals of, effects of plastic deformation on, 18: 34280(R) (NYO-2680-1)
radioinduced color centers in, mechanism of x, 18: 34280(R) (NYO-2680-1)
radioinduced color centers in, effects of plastic deformation on, 18: 34280(R) (NYO-2680-1)
radioinduced dislocations in, motion of, 18: 34276 (NP-14129)
radioinduced luminescence at 4 to 80°K, x, 18: 33648
spectra of F centers in, saturation of EPR, 18: 35243(R) (IITRI-1184-13)
KCl–NaCl, interface phenomena with liquid lead, 18: 34050(R) (ORNL-3626(p.59-164))
LiCl–KCl, spectra of lithium telluride at 500°C in, absorption, 18: 35060(R) (ANL-6904)
$PuCl_3$–KCl–NaCl, phase studies and properties as reactor fuels, 18: 34050(R) (ORNL-3626(p.59-164))

POTASSIUM CHROMATES
analytical use for titrimetric determination of cerium, iron, manganese, uranium, and vanadium, 18: 33496

POTASSIUM CYANOMOLYBDATES(IV)
oxidation by cerium and iridium chloride, electron-transfer reactions in, 18: 33550
oxidation of iron and tungsten cyanide complexes by, electron transfer reactions in, 18: 33550

POTASSIUM FLUORIDES
KF–NaF–ThF_4, phase studies and properties as reactor blankets, 18: 34050(R) (ORNL-3626(p.59-164))

POTASSIUM IODIDES
beta scattering by, measurement of saturated backscattering from, 18: 35057
scintillation processes in crystals of, 18: 33636

POTASSIUM ISOTOPES
separation in calutrons, 18: 34007(R) (ORNL-TM-890)

POTASSIUM ISOTOPES K-37
energy level at 2.73 Mev, 18: 34791

POTASSIUM ISOTOPES K-39
proton reactions (p,γ) with, cross sections, 18: 34752(R) (CU(PNPL)-234)
proton reactions (p,γ) at 1103 to 1153 kev, spectra for, 18: 34784

POTASSIUM ISOTOPES K-40
determination in humans by whole-body counting, *in vivo* determination of lean body mass from, 18: 33487
determination in liquids, gamma spectrometric, 18: 33485
energy levels of, supermultiplet and unitary symmetries classification in collective model for, 18: 34897

POTASSIUM ISOTOPES K-42
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
determination in urine and feces, gamma spectrometric, 18: 33264
determination of physico-chemical state in liquid media, by paper electrophoresis and radioactivity recording, 18: 33590
diagnostic use of, calibration methods for, 18: 34274(R) (NIRS-2 (p.3-15))
separation from sodium-24, electrophoretic, 18: 33590
uptake by human kidneys, factors affecting, 18: 33238

POTATOES
radiation effects on seed, x, 18: 33376
separation from ground lumps, use of gamma rays in automatic, 18: 33991(T) (AEC-tr-6399(p.277-85))

POTENTIOMETERS
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))

POWDERS
flow of, valve for control of, 18: 33712 (HW-53440)

POWER BREEDER REACTORS
power production in fast, liquid-metal-cooled, MHD impact flow tube for, 18: 35166(T) (ANL-Trans-38)

POWER CYCLES
development of Rankine, for nuclear space propulsion, 18: 35216

POWER PLANTS
design and development of thermionic and turboelectric, 18: 35197(R) (64SD700)
design of portable, using mercury Rankine cycle, 18: 33721
phase separator for Rankine-cycle, for space vehicles, 18: 33701
thermodynamics of French, 18: 35169

POWER REACTORS
core support within concrete pressure vessel, 18: 35101(P)
design feasibility of heavy-water, up to 8300 Mw(th), 18: 35143(R) (DP-915)
design of core assembly for high-temperature gas-cooled, 18: 35189(P)
development of Canadian, 18: 35173
development of, review of, 18: 35178
development of, role of research reactors in, 18: 35148 (IA-891)
development status, 1963, 18: 35066 (STI/DOC/10/28(p.73-7))
economics of natural-uranium, 18: 35170
economics of water-cooled, 18: 35174
fuel element cladding behavior in steam and water environments, 18: 34076 (TID-8540(p.213-330))
fuels for fast, development and testing of ceramic, 18: 35146(R) (GEAP-4601)
heat exchangers for gas-cooled, survey, 18: 35150 (NYO-9789)
neutron flux measurements in, development of equipment for, 18: 35247(R) (NAA-SR-9700)
noise sources in, 18: 35155 (TID-7679(p.357-68))
optimization of gas- and water-cooled, 18: 35179
review, 18: 35161 (TID-8540(p.71-129))
review and survey of gas- and water-cooled, 18: 35160 (TID-8540 (p.1-69))
steam cycles for, economics of high-pressure and -temperature, 18: 35188
steam pressure effects on economics of, 18: 35184
use in Pakistan, 18: 35257
waste gas handling in boiling, 18: 35181

POWER SUPPLIES
development of Mw d-c–to–d-c converters for space uses, 18: 34497(R) (NP-12888(Vol.5))
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))

PRASEODYMIUM
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
solubility in cadmium–magnesium–zinc alloys, 18: 33678(R) (ANL-6875)

PRASEODYMIUM ISOTOPES Pr-142
beta spectra of, mean energy of, 18: 34954

PRASEODYMIUM ISOTOPES Pr-143
beta decay of, mean energies of, 18: 34785

PRASEODYMIUM ISOTOPES Pr-144
determination in liquids, gamma spectrometric, 18: 33485

PREGNANCY
radiation injuries during, in Nagasaki, 18: 33391

PRESSURE
measurement in reactor, 18: 35089 (TID-8540(p.177-211))

PRESSURE GAGES
calibration of piezoelectric, use of knock-off tube as quick pressure-release mechanism for, 18: 33829 (NOLTR-63-134)
design of, using alpha particle attenuation, 18: 33874(P)

PRESSURE VESSELS
containment vessel for boiling reactors, 18: 35099(P)
design of prestressed concrete, for Marcoule reactors, 18: 35196
fabrication of, metallurgical problems in, 18: 34097
leak rates of concrete and metal, 18: 35247(R) (NAA-SR-9700)
leakage rate detection in, evaluation of errors in, 18: 33757
materials for reactor, properties of, 18: 34181
radiation effects on steels, research program on fast-neutron, 18: 34219 (RCN-26)
shielding from hot gas coolant and neutron beams in gas-cooled reactors, 18: 35109(P)
thermal barrier for prestressed concrete, in gas-cooled reactors, 18: 35104(P)

PRESSURIZED WATER REACTORS
design for fuel testing, 18: 35233(P)
design for Karachi power plant, 18: 35183
economics, 18: 35174
fuel burnup and inventory charges for, 18: 35151 (ORNL-TM-564)
fuel element cladding behavior in, 18: 34076 (TID-8540(p.213-330))
noise measurements for Saxton, 18: 35156 (TID-7679(p.427-47))
steam generation without heat exchanger, 18: 35190(P)
steam pressure effects on economics of, 18: 35184

PRIMARY CELLS
radiation effects on unsaturated acid Weston cadmium cells, 18: 34217 (NP-14183)

PRINCETON SYNCHROTRON
beam survey for 60° (lab.), 18: 34380

PROCAINE
radiation effects on effects of, on blood pressure in rabbits, 18: 33304

PROCESS HEAT REACTORS
development for desalination of water, 18: 35178

PROMETHIUM

separation from rare earths by solvent extraction, 18: 34006(R) (ORNL-TM-889)
PROMETHIUM COMPOUNDS
deposition on silicon, 18: 34034(R) (BMI-1672(Del.))
PROMETHIUM ISOTOPES Pm-147
beta decay of, mean energies of, 18: 34785
neutron reactions (n,γ) with, macroscopic cross section for, 18: 34006(R) (ORNL-TM-889)
properties for use as heat source in direct conversion devices, 18: 34002
separation from americium-241 by anion exchange, 18: 34006(R) (ORNL-TM-889)
separation from Hanford wastes for use as heat sources, 18: 33983 (HW-SA-3080(Rev.))
use in betavoltaic cells, 18: 34034(R) (BMI-1672(Del.))
PROMETHIUM ISOTOPES Pm-148
beta particles from, polarization of, 18: 34877
determination of, differential absorption, 18: 34006(R) (ORNL-TM-889)
PROPANE
radiolysis of deuterated, effects of electric fields on gamma, 18: 33642
radiolysis of hydrogen in deuterated, proton transfer reactions of H_3^+ in, 18: 33639
2-methylbutane–propane, fugacity coefficients from equation of state for, 18: 33531 (UCRL-11359)
PROPANE, 2,2-DIMETHYL-
radiolysis of hydrogen in deuterated, proton transfer reactions of H_3^+ in, 18: 33639
PROPANE, 1-IODO-
molecule scattering at thermal energies, total cross sections for, 18: 34407 (UCRL-11071)
scattering by molecules at thermal energies, total cross sections for, 18: 34407 (UCRL-11071)
PROPANE, 2-IODO-
molecule scattering at thermal energies, total cross sections for, 18: 34407 (UCRL-11071)
scattering by molecules at thermal energies, total cross sections for, 18: 34407 (UCRL-11071)
PROPANE, 2-METHYL-
radiolysis of hydrogen in deuterated, proton transfer reactions of H_3^+ in, 18: 33639
reactions with tritium atoms, steric effect in displacement, 18: 33640
1,3-PROPANEDIONE, 1,3-DIPHENYL-
complexes with europium, quenching and temperature dependence of fluorescence in, 18: 33556
1-PROPANETHIOL, 2-AMINO-
radiation effects on distribution and elimination of carbon-14 labeled-, in mice, 18: 33373
2-PROPANOL
effects on radioinduced polymerization modification of acrylonitrile, 18: 33650
PROPENE, 2-METHYL- POLYMERS
radioinduced crosslinking of, in presence of allyl acrylate, 18: 33652
PROPENE POLYMERS
radiation effects on structure of, gamma, 18: 34243
sorptive properties for young fission products from solutions, 18: 33448 (IDO-14644)
spectra in isotactic and atactic, neutron scattering studies of low-frequency vibrational, 18: 34265 (BNL-7320)
PROPIONITRILES
nitrogen-14 NQR in, relaxation of, 18: 33615
PROPORTIONAL DETECTORS
dosimetry using boron trifluoride, fast neutron, 18: 33980(P)
efficiency for copper Kα emission, 18: 33896
properties of boron trifluoride, for neutron dosimetry, 18: 33951
review, 18: 33967
use of 4π, for absolute activity measurement of beta sources, 18: 33946
PROPULSION
arc-jet, use in manned orbiting research laboratory, 18: 33706
electric, d-c–to–d-c converters for space, 18: 34497(R) (NP-12888 (Vol.5))
electric, properties of semitoroidal reflex discharge for, 18: 34290
electron-bombardment ion thrustor, performance of heavy-molecule propellants in, 18: 33696 (NASA-TN-D-2401)
fusion, for space flight, 18: 34973 (ASD-TDR-63-696)
ion, automatic control systems for, 18: 33698
ion, performance of large systems for, 18: 33704
ion, status of arc-jet, 18: 33705
ion, system design for, 18: 33699
nuclear, development status of, 18: 35216
radiochemical, using isotopes, 18: 34003
requirements for unmanned scientific planetary missions, 18: 35197(R) (64SD700)
systems for space-vehicle, status of electric, 18: 33702
PROTACTINIUM ISOTOPES Pa-231
determination in urine, 18: 33518
determination, method for trace, 18: 33495
PROTACTINIUM ISOTOPES Pa-233
determination in irradiated thorium, 18: 33462 (DP-883)
determination in urine and feces of, gamma spectrometric, 18: 33264
PROTACTINIUM ISOTOPES Pa-234
gamma transitions in, half lives for 63- and 93-kev, 18: 34803
PROTEINS
binding of rat liver, with carcinogenic *N*-methylated aminoazo dyes, 18: 33449(R) (NIRS-2(p.15-19))
fractionation of, by column chromatography, 18: 33212(R) (NYO-2570-1)
radiation and burn injury effects on content of, in rats, 18: 33381
radiation effects on levels in regenerating rat liver, x, 18: 33301
radiation effects on content of, in rat blood serum, 18: 33335
radiation effects on electrophoretic distribution of, in blood serum, 18: 33353
radiation effects on metabolism of rat blood, x, 18: 33362
radiation effects on synthesis of, in rat spleen, 18: 33382
radiosensitivity effects of content of, on bacteria, 18: 33310
synthesis in rat thyroid, effects of iodine metabolism on, 18: 33212(R) (NYO-2570-1)
synthesis of, effects of 5-bromouradine on, 18: 33212(R) (NYO-2570-1)
PROTON BEAMS
phase-space occupation of, 18: 34641
polarization analyzer for 15- to 30-Mev, design of, 18: 33949
production for shield testing, 18: 34374
separator design for, crossed-field, 18: 34365 (BNL-8145)
PROTONS
biological effects of high-energy, in mice, rats, and dogs, 18: 33286(T) (UCRL-Trans-1068)
detection at high temperatures, silicon carbide detector for, 18: 33918
detection using alkali halide crystals, scintillation efficiencies for, 18: 33636
emission by sun, geophysical effects of, 18: 34388
emission in decay of $Z > 50$ nuclei, 18: 34767 (JINR-P-1706)
emission in oxygen-16 reactions with nuclei at 167 Mev, spectra of, 18: 34780 (UCRL-11349)
energy loss in hydrogen, 18: 35060(R) (ANL-6904)
interactions with protons at 8.3 Bev, nuclear emulsion study of elastic, 18: 34508 (JINR-P-1674)
interactions with antiprotons, statistical model for, 18: 34511(R) (NYO-2584-1)
interactions with mesons (π^-) at 310 Mev, neutron polarization and phase-shift analysis in, 18: 34512 (UCRL-11140)
interactions with mesons (K^-) at 2.45 and 2.7 Bev/c, $\Lambda\mu^+\mu^-$ and Λe^+e^- production in, 18: 34513 (UCRL-11428)
interactions with mesons (K^-) at 2.4 to 2.7 Bev/c, bubble chamber studies of final-state resonances in, 18: 34514 (UCRL-11430)
interactions with mesons (K^-) at 2.4 to 2.7 Bev/c, production of 959-Mev resonance in, 18: 34515 (UCRL-11431)
interactions with mesons (π^-) at 313 and 371 Mev, distribution of neutrons from charge-exchange and inelastic, 18: 34516 (UCRL-11435)
interactions with mesons (K^-) at 2.4 to 2.7 Bev/c, (Ξ-π) resonance (1530 Mev) spin and parity from, 18: 34517 (UCRL-11436)
interactions with mesons (π^-) at 7 and 16 Bev/c, quasi-elastic contribution to, 18: 34520
interactions with mesons (π^+), phenomenological model for, 18: 34533
interactions with photons, hyperon (Λ) and meson (K^+) production in, 18: 34536
interactions with deuterons at 32 and 40 Mev, impulse approximation for elastic, 18: 34537
interactions with mesons (π^-) at 10 Bev/c, meson (π^0) production in, 18: 34542
interactions with mesons (K^+) to 450 Mev, 18: 34543
interactions with deuterons at 40 Mev, polarization in elastic, 18: 34550
interactions with mesons (π^-) at 285 Mev, final-state (π-π) effects in, 18: 34552
interactions with photons, hyperon (Σ) production in, 18: 34566
interactions with mesons ($\pi^\pm$) at 2.5 to 5.5 Bev/c, total cross sections for, 18: 34584
interactions with mesons, SU(3) symmetry in, 18: 34586
interactions with photons at 1280 Mev, hyperon (Σ^+) production in, 18: 34591
interactions with neutrons, charge-independent pairing in, 18: 34600
interactions with protons at 660 Mev, phase-shift analysis of, 18: 34601
interactions with protons at 970 Mev, phase-shift analysis of, 18: 34602
interactions with protons, meson (π^0) contribution to, 18: 34610
interactions with deuterons at 6.2 Bev, differential cross sections for elastic, 18: 34616

interactions with mesons (π) and photons, vector meson production in, 18: 34620
interactions with mesons (π^+) at 3.54 Bev/c, meson (ρ) exchange mechanism in, 18: 34626
interactions with mesons (π^-) at 3.5 Bev/c, meson (π^+)-meson (π^+) resonance in, 18: 34630
interactions with protons at 2 Bev, single meson (π) production in, 18: 34633
interactions with mesons (π^+), meson (π-ρ) resonance in, 18: 34581
interactions with antineutrinos, scintillation detector for, 18: 33901
interactions with neutrons, meson effects in nuclear, 18: 34915
interactions with protons, spin-orbit potentials for, 18: 34931
interactions with deuterons at 24 Mev, proton energy spectra from disintegration, 18: 34771 (NP-14175)
nuclear magnetic resonance in nickel fluosilicate, 18: 34275 (NP-14114)
pairing forces in deformed nuclei, 18: 34939
polarizability of, electric and magnetic, 18: 34526
polarization in elastic proton-deuteron scattering at 40 Mev, 18: 34550
production in electron reactions with light nuclei at 1 and 4 Bev, 18: 34916
reactions (p,α) at 11 and 12.5 Mev, 18: 34855
reactions (p,α) with magnesium-25 at 9 Mev, 18: 34821
reactions (p,γ) with lithium-7 at 800 to 1700 kev, 18: 34875
reactions (p,γ) with aluminum, yield curves for, 18: 34917
reactions (p,γ) with phosphorus-31, 18: 34924
reactions (p,γ) with nuclei, cross sections for, 18: 34752(R) (CU(PNPL)-234)
reactions (p,γ) with potassium-39 at 1103 to 1153 kev, spectra for, 18: 34784
reactions (p,γ) with iron-57, cobalt-57 decay scheme from, 18: 34792
reactions (p,γ) with chromium-50, 18: 34793
reactions (p,γ) with chromium-52, 18: 34797
reactions (p,d) with boron-10 at 11 Mev, boron-9 energy levels from, 18: 34892
reactions (p,d) with calcium-40 at 55 Mev, differential cross sections for, 18: 34757 (INSI-72)
reactions (p,d) with iron-56 at 28 Mev, distorted-wave approximation for, 18: 34774 (ORNL-P-144)
reactions (p,n) with medium-mass nuclei at 7 to 13 Mev, 18: 34859
reactions (p,n) with heavy nuclei at 0.3 to 1.0 Bev, Monte Carlo calculations for, 18: 34961
reactions (p,pγ) with sodium-23 at 828 to 1100 kev, excitation and resonances in, 18: 34836
reactions (p,pπ^+) with indium-115 at 130 and 200 Mev, yields from, 18: 34946
reactions (p,3n) with fluorine-19, neon-17 yield from, 18: 34899
reactions in nuclear emulsion, radii for, 18: 34964
reactions on helium, excitation in, 18: 34445
reactions with aluminum-27, angular correlations in, 18: 34822
reactions with atomic hydrogen, distorted-wave approximation for resonant charge-transfer, 18: 34447
reactions with beryllium at 3 Bev, deuterons, mesons(π), protons, and tritons from, 18: 34380
reactions with carbon films at 992 kev, energy-loss distributions in, 18: 34918
reactions with carbon-12, Monte Carlo calculations on cascade, 18: 34922
reactions with carbon, meson (μ^-) exchange in, 18: 34947
reactions with emulsion nuclei at 2 to 9 Bev, fragment angular correlations for, 18: 34940
reactions with ethane and ethylene molecules at 200 to 1200 kev, mass spectra of fragments from, 18: 34433
reactions with excited hydrogen atoms, matrix elements for charge-exchange, 18: 34432
reactions with excited hydrogen atoms, cross sections for charge-exchange, 18: 34434
reactions with gases, electron angular and energy distributions from ionization, 18: 34404(R) (COO-1277-5)
reactions with lithium-drifted silicon detectors, damage effects in, 18: 33913
reactions with silicon crystals at 2.1 Mev, channeling in, 18: 33917
reactions with tantalum at 660 Mev, terbium production in, 18: 34766 (IINR-P-1687)
scattering by aluminum and copper at 75 to 193 kev, angular distributions for, 18: 34943
scattering by argon-36, resonances in, 18: 34791
scattering by carbon at 6.7 Mev, 18: 34809
scattering by carbon-12 at 147 Mev, inelastic, 18: 34816
scattering by carbon-12 at 5 to 60 Mev, crossover technique for energy determination in, 18: 34934
scattering by copper-63 at 7 to 11 Mev, inelastic, 18: 34862
scattering by magnesium isotopes, parameters for inelastic, 18: 34752(R) (CU(PNPL)-234)
scattering by nuclei, diffraction mechanism for elastic, 18: 34848
scattering by tritium at 300 to 900 kev, differential cross sections for, 18: 34944
scattering in nuclear emulsions at 27 Bev, multiple, 18: 34627
scattering in nuclear emulsions at 24 Bev, spurious, 18: 33963
spin densities in methyl group, 18: 33548
transfer reactions in radiolysis of hydrogen in presence of deuterated hydrocarbons, 18: 33639

PROTOZOA
bioluminescence of *Noctiluca miliaris*, microscopy of, 18: 33221
radiation effects on Toxoplasma, 18: 33331
5-ribosyluracil-5'-monophosphate synthesis in *Tetrahymena pyriformis*, 18: 33246

PSEUDOUREA, 2-(2-AMINOETHYL)-2-THIO-
protective effects against giant cell formation in HeLa animal cells, 18: 33405
radiosensitivity effects on mice grafted with cancer cells, 18: 33407

PULSE ANALYZERS
design and development of, summary, 18: 34752(R) (CU(PNPL)-234)
design and performance of tunnel-diode fast discriminator, 18: 33835 (RT/EL(64)-3)
design and performance of amplitude, with moving-film photography, 18: 33893
design of transistorized time-to-pulse-height, 18: 33930
design of transistorized time-to-pulse-height, 18: 33931
development for particle discrimination by time-of-flight methods, 18: 33932
programmers for two-dimensional pulse-height, external, 18: 33960

PULSE GENERATORS (ELECTRONICS)
design for Mössbauer studies, 18: 33834 (RT/EL(63)-15)
development of recycling, 18: 33857

PULSE INTEGRATORS
design for portable neutron dose rate meter, 18: 33878 (HW-81774)

PULSE MODIFIERS
development of high-speed analog pulse dividers for semiconductor detectors, 18: 33929
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))

PUMPS
cooling of motor of, in nuclear power plant, 18: 35191(P)
development for nuclear space propulsion systems, 18: 35216
performance of sorption, at cryogenic temperatures, 18: 34282(R) (TID-20837)

PUREX PROCESS
waste calcination and solidification, development of equipment and techniques for, 18: 35234(R) (HW-81862)
waste processing by ion exchange and solvent extraction, 18: 35234(R) (HW-81862)

Q

QUANTUM ELECTRODYNAMICS
electron propagator in two-component formulation of, 18: 34646
testing of, meson (μ) pair photoproduction experiment on, 18: 34594

QUANTUM MECHANICS
analytic continuation and nonrenormalizable states in, with nested Hilbert spaces, 18: 34651
charged particle motion in hydrodynamical model of, 18: 34638
commutation relation of harmonic oscillator in, uniqueness of, 18: 34662
Green functions, theory and applications of, 18: 34648
many-body problems in, new identity in Green's function approach to, 18: 34661
operator for radial kinetic energy in Schroedinger equation for central force, 18: 34640
plasma dynamics in statistical, 18: 34971 (ARL-64-85)
quantization of Schroedinger equation, canonical, 18: 34639
scattering solutions for Schroedinger equation, 18: 34652
statistical, of degenerate boson system, 18: 34337
statistical, of degenerate boson system, lambda transformation in, 18: 34338
statistical, of degenerate boson system, 18: 34339
ultrasonic wave absorption by electrons in, 18: 34454
wave equations in, energy eigenvalues for, 18: 34660

QUARTZ
analysis for sodium, activation, 18: 33494
neutron filtering properties of "single" crystals of, 18: 34752(R) (CU(PNPL)-234)
oxygen isotope fractionation between calcite, magnetite and, for geothermometry, 18: 33785
radiation effects on crystal structure of, fast neutron, 18: 34241

use of crystal of, in circuit for measuring reactor temperature, 18: 33872(P)
QUINOLINE,4-NITRO-1-OXIDE
mutagenic effects in Drosophila, 18: 33273(R) (NIRS-2(p.42-8))
QUINONE, 2,5-DIBROMO-3,6-DIHYDROXY-
analytical use for spectrophotometric determination of hafnium and zirconium, 18: 33498

R

RABBITS
bone marrow regeneration in, 18: 33216
effects of ozone on myocardial cell nuclei in, 18: 33334
radiation effects on phagocytic activity of neutrophils in, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on procaine effects on blood pressure in, 18: 33304
radiation effects on electrophoretic distribution of blood serum proteins, 18: 33353
radiation effects on blood pressure in, gamma, 18: 33364
radiation effects on, development of conditioned reflex to gamma, 18: 33366
radiation effects on typhoid immunity in, x, 18: 33369
radiation effects on skin graft acceptance by, effects of post-irradiation time on, 18: 33386
radiation effects on heme synthesis in, 18: 33400
radiodermatitis in, effects on trace element content of skin and blood, 18: 33285(T) (JPRS-25502)
radioinduced atherosclerosis in, 18: 33277 (STI/DOC/10/28(p.21-38))
strontium-90 and calcium-45 metabolism in bones of, 18: 33261
RADIATION
biological effects of, research program on free radical production and secondary electron spectra in, 18: 33274(R) (NYO-910-1)
biological effects in domestic animals, 18: 33300
biological effects of, from internal sources, 18: 33328
biological effects of ionizing, 18: 33397
biological effects on man, 18: 33401
carcinogenic effects of, comparison with spontaneous incidence, 18: 33299
chromosome aberrations induced in mice by, comparison of nucleic acid with, 18: 33309
dose to medical personnel applying iodine-131 thyrotoxicosis therapy, 18: 33421
dose to tissues, determination of, 18: 33428
dosimetry at Risö, 18: 33807 (RISO-78)
dosimetry of AB Atomenergi personnel, 18: 33798(R) (AE-147)
effects of Thorotrast, on kidneys, 18: 33426
effects on acetylcholine and sympathin content in rat brain, effects of aminazine on, 18: 33325
effects on animals and man, hematopoietic, 18: 33291
effects on blood picture and survival of mice, effects of hormones on, 18: 33416
effects on carcinomatous and normal tissues, pathologic study of, 18: 33296
effects on cell growth in rats, 18: 33307
effects on colloids, 18: 33283(R) (TID-20889)
effects on encysted dry eggs of Artemia, fractionated-dose, 18: 33272(R) (NIRS-2(p.31-42))
effects on giant cell formation in HeLa cells, protective effects of chemical substances against, 18: 33405
effects on guinea pig blood picture, 18: 33363
effects on liberation of polydesoxyribonucleotide from tissues, 18: 33308
effects on lymph system, specificity of, 18: 33272(R) (NIRS-2(p.31-42))
effects on mouse sensitivity to bacterial endotoxins, 18: 33370
effects on Nissl granules in rat spinal cord neurons, 18: 33349
effects on plant cell membrane formation, 18: 33372
effects on plants, 18: 33284(T) (AEC-tr-5836)
effects on procaine effects on blood pressure in rabbits, 18: 33304
effects on rats, effects of energy balance on, 18: 33365
effects on rats, protective effects of physostigmine against, 18: 33306
effects on rats, therapeutic effects of splenectomy on, 18: 33415
effects on regulation of fish melanophores, 18: 33272(R) (NIRS-2(p.31-42))
effects on role of oleic acid oxidation products in yeasts, 18: 33390
effects on sodium metabolism by fish, 18: 33272(R) (NIRS-2(p.31-42))
effects on sorption in mouse brain and kidneys, 18: 33358
effects on telophase chromosomes, microbeam, 18: 33271(R) (NIRS-2(p.26-31))
effects on testicular androgen biosynthesis, 18: 33316
effects on *Toxoplasma gondii*, 18: 33331
effects on trypsin and chymotrypsin, 18: 33283(R) (TID-20889)
effects on vaginal cells, 18: 33348
effects on Weston cadmium cells, 18: 34217 (NP-14183)
effects with burn injury on amino nitrogen, nonprotein, protein fractions, and serum protein contents in rats, 18: 33381
genetic effects in human populations, 18: 33336
leukemogenic effects of chronic occupational exposure, 18: 33347
on defects in germanium and silicon, 18: 34216 (NASA-TN-D-2364)
somatic pathological effects of, 18: 33396
uses of, review of Canadian, 18: 35171
RADIATION CHEMISTRY
book: *Advances in Catalysis and Related Subjects*, 18: 33453
of calcium and sodium phosphates, hydrogen yields in, 18: 33645
of deuterated propane, effects of electric fields on, 18: 33642
of hydrogen in presence of deuterated hydrocarbons, proton transfer reactions of H_3^+ in, 18: 33639
of thymidine, 18: 33658
of 11-oxo-steroids, yields in uv, 18: 33634
photochemical rearrangement of 3-oxo-4,5-oxido-steroids, uv, 18: 33635
synthesis of glycol from methanol and nitrogen oxides in air, 18: 33629
RADIATION DAMAGE
in graphite, removal by reirradiation and low-temperature annealing, 18: 34230
RADIATION DETECTION INSTRUMENTS
book: *Nuclear Radiation Detectors*, 18: 33967
counting statistics for, generating functions in, 18: 33964
design and development of, summary, 18: 34752(R) (CU(PNPL)-234)
design for chromatogram reading, 18: 33490
design of mobile whole-body counter, 18: 33802 (HW-80216)
efficiency of, analysis of effects of dead time on, 18: 33899
performance of secondary-emission monitors for electron beams, 18: 34258(R) (AD-417250)
sample changer design for, 18: 33982(P)
RADIATION DETECTION INSTRUMENTS (COLORIMETRIC)
description and properties of silver-activated phosphate-glass microdosimeter system, 18: 33880 (NDL-SP-6)
RADIATION DETECTION INSTRUMENTS (ION CURRENT TYPE)
response to gamma radiation, determination of, 18: 33883 (ORNL-TM-897)
RADIATION DETECTION INSTRUMENTS (PULSE TYPE)
design and performance for shielding studies, 18: 33886(T) (JPRS-25467(p.9-24))
design and performance of time-compensated, with 0.9 nsec resolution, 18: 33972
design for cosmic rays at 9 to 12 km, 18: 34464(T) (NASA-TT-F-126 (p.180-6))
design for cosmic-ray intensity measurements, 18: 33890(T) (NASA-TT-F-126(p.177-9))
design for detection of gross beta-gamma contamination on hands and feet, 18: 33877 (DP-893)
design for measuring low beta activities in liquids, 18: 33974(P)
design of contamination monitor for distinguishing between alpha and beta activity, 18: 33973(P)
design of counter-tube, for measurement of large dosages, 18: 33975(P)
development of, for visualization of isotope distribution on colored scintigrams, 18: 33968
efficiency for copper Kα emission, 18: 33896
pulse counters for, development of high-speed decade, 18: 33956
pulse integrator for portable neutron dose rate meter, 18: 33878 (HW-81774)
pulse spectrometry in, generating functions in, 18: 33964
pulse-height analyzers for, programmer for two-dimensional, 18: 33960
RADIATION EFFECTS
bibliography on, on corrosion, 18: 34036 (CEA-Bib-16)
on corrosion, bibliography on, 18: 34036 (CEA-Bib-16)
on electrical and electronic materials, handbook on, 18: 34245
on telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
on telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
RADIATION INJURIES
from head therapy, 18: 33422
human nephritis, 18: 33332
in rat offspring, 18: 33312
of adolescents in Nagasaki, 18: 33391
of bones of head after radiotherapy, 18: 33338
of mice, effects of bone marrow and spleen cell transplants on, 18: 33320
of rectum, effectiveness of novocain sacral block for relief of pain from, 18: 33339
of skin in guinea pigs, effects of treatment with cigerol and linol, 18: 33413
of skin of rats, 18: 33340
protection against, using previously-aspirated bone marrow in mice, 18: 33223

protection against, using amines in mice, 18: 33277 (STI/DOC/10/28 (p.21-38))
protection against, using isologous and homologous DNA in rats, bacteria, and L-cells in culture, 18: 33277 (STI/DOC/10/28(p.21-38))
protection against, effects of ACTH in rats, 18: 33411
protection against, in embryos of rats and mice, 18: 33423
recovery from gamma, dose effects on, 18: 33377
recovery from, statistical model for cellular, 18: 33355
repair of esophagus by free tracheal graft, 18: 33219
resulting from injected strontium-90 in dogs, 18: 33342
therapeutically induced factitial proctitis, 18: 33330
therapy, 18: 33328
vasulopathophysiologic, radiographic method for determining, 18: 33289

RADIATION MONITORING
instrumentation for in-pile, technology review of, 18: 35089 (TID-8540 (p.177-211))
of personnel, design of hand and foot monitor for gross beta-gamma contamination, 18: 33877 (DP-893)

RADIATION PROTECTION
from environmental contamination, role of veterinarian in France, 18: 33300
guides applicable to general population, 18: 33430
in industrial use of radioisotopes, 18: 33994
methods for space-flight, 18: 33815
methods of, for personnel working with radioactive material, 18: 33395
of populations, 18: 33401
public health activities concerning, in France, 18: 33816
requirements for radiation testing, 18: 34223
shielding data for ducts in radiation facilities, 18: 35049

RADIATION SICKNESS
effects on fetus, placenta, and pregnancy, 18: 33395
effects on lysine metabolism in calcified tissues in rats, 18: 33346
nucleated cell depletion in bone marrow in, 18: 33351
protection against, using *N*-methylaminoethylthiosulfuric acid, 18: 33418(P)
protective effects of bone marrow hemopoietic cell transplantations against, in man, 18: 33403

RADIATION SOURCES
collimator response to moving point source, 18: 33969
correlation measurements on, geometrical corrections in triple, 18: 33952
housing for, design of remotely operated, 18: 33728(P)

RADIATION TARGETS
performance of titanium–tritium, 18: 34375

RADIATORS
design and development for thermionic- and turboelectric-powered space vehicles, 18: 35197(R) (64SD700)
development for nuclear space propulsion systems, 18: 35216

RADIO WAVES
absorption in auroral storms, effects of nonthermal electrons on, 18: 34254
emission by flare stars, 18: 34395
propagation across velocity discontinuity in plasma, 18: 34991
propagation in time-varying plasma, 18: 34970 (AFCRL-64-250)
transmission from satellites, amplitude fluctuations in, 18: 34253
transmission of vlf, effects of high-altitude nuclear explosions on, 18: 34250 (AWRE-O-35/64)

RADIOACTIVE CONTAMINATION
accidents involving, handling of, 18: 33817
monitoring of, instrument with means for distinguishing between alpha and beta activity, 18: 33973(P)
of ground around cavity of underground nuclear explosion, 18: 33766 (HNS-1229-47)

RADIOACTIVE MINERALS
determination by x-ray-diffraction analysis, tables of *d* spacings and intensities for, 18: 33794 (NP-14176)

RADIOACTIVITY
book: *Nuclear and Radiochemistry*. Second Ed. 18: 33455
determination of internal, by radiochemical urine analysis, 18: 33519
measurement of neutron-induced, nomographs for, 18: 34012
measurements in marine organisms, 18: 33230
monitoring artificial and natural, of seas and oceans during 1959–1960, 18: 33779
relation of internal, to surface heat flow of earth, 18: 33774

RADIOAPPLICATORS
design of strontium-90 needle, 18: 33436
remote afterloading procedure for, 18: 33446

RADIOBIOLOGY
biological dosimeter of threshold radiation effects, 18: 33278 (STI/DOC/10/28(p.39-66))
book: *Physical Basis of Radiotherapy and Radiobiology*, 18: 33228
problems in radioisotope utilization, 18: 33420
radiation effects on plants, review, 18: 33284(T) (AEC-tr-5836)
radiation effects survey, 18: 33397
research at Argonne Cancer Research Hospital, 1963, 18: 33211(R) (ACRH-21)
scintillation counter methods in, 18: 33220

RADIOCHEMICAL PROCESSING PLANTS
automation and instrumentation in, 18: 33856
safety in, role of nuclear materials management in assurance of, 18: 33799 (CONF-620-2)

RADIOCHEMISTRY
book: *Nuclear and Radiochemistry*. Second Ed., 18: 33455
energy transfer in Szilard-Chalmers reactions, review on theory of, 18: 33660
radioisotopes and counting methods for, method for choosing optimum, 18: 33655

RADIODERMATITIS
effects on content of trace elements in skin and blood, 18: 33285(T) (JPRS-25502)

RADIODIAGNOSIS
gonadal doses from, 18: 33419
of brain circulatory diseases, 18: 33441
of brain tumors by positron scanning after injection of arsenic-74 or copper-64, 18: 33432
of cancer of esophagus, by differential uptake of phosphorus-32, 18: 33438
of kidney diseases, precautions for, 18: 33433
whole-body counter for use in, development of high-level, 18: 33937

RADIOFREQUENCY SPECTROMETERS
sensitivity of NMR, enhancement of, 18: 33866
spin decoupler for NMR, development of, 18: 33864

RADIOGRAPHY
developments in, 18: 35207
exposure meter for gamma defectoscopy, 18: 33854(T) (AEC-tr-6399 (p.221-6))
method for radiation vasculopathophysiologic effects determination, 18: 33289
radiation hazards from diagnostic, 18: 33401

RADIOISOTOPES
biological effects of internally deposited, 18: 33328
content of gamma-emitting, in rain water, 18: 33805(R) (NIRS-2(p.57-67))
determination of gamma-emitting, by spectrometer channel ratio, 18: 33489
determination of retention in body of gamma-emitting, development of whole-body counter for, 18: 33937
distribution around cavity of underground nuclear explosion, analysis of, 18: 33766 (HNS-1229-47)
excretion rates of, determining tissue dose by, 18: 33428
gamma spectra of, compilation of, 18: 34756 (IDO-16880-2)
industrial uses of, review of regulations for radiation protection in, 18: 33994
industrial uses of, review of Canadian, 18: 35171
production by neutron activation, nomographs for, 18: 34012
production by neutron activation, interfering reactions in, 18: 33492
properties as heat sources, survey, 18: 33983 (HW-SA-3080(Rev.))
uptake by marine organisms, 18: 33230
uptake by soil, 18: 35239
use in automatic control, Russian conference on, 18: 33986(T) (AEC-tr-6399)
use in space power systems, 18: 34001
use in space propulsion, 18: 34003
uses in plant research, 18: 33284(T) (AEC-tr-5836)
uses of reactor by-product, review of, 18: 33984 (TID-8540(p.477-528))
uses of, radiobiological aspects of, 18: 33420
volumetric dispenser for solutions of, automatic, 18: 33653

RADIOLOGICAL TELEMETERING SYSTEMS
design of count-time radiometer, 18: 33885(T) (AEC-tr-6399(p.173-6))
efficiency of data transmission in well logging, improvement of, 18: 33853(T) (AEC-tr-6399(p.207-20))

RADIOMETERS
design of count-time tele-, 18: 33885(T) (AEC-tr-6399(p.173-6))

RADIOMETRIC ANALYSIS
equipment for beta analysis of binary liquids, 18: 33473(T) (AEC-tr-6399(p.115-23))

RADIOPROTECTIVE COMPOUNDS
effects of cigerol and linol treatment on radioinduced skin lesions in guinea pigs, 18: 33413
effects on mucopolysaccharides in irradiated rats, 18: 33277 (STI/DOC/10/28(p.21-38))
effects on radioinduced changes in stored blood, 18: 33345
preparation and properties of *N*-methylaminoethylthiosulfuric acid as,

18: 33418(P)
properties of, for embryo and mothers, 18: 33395
RADIOSENSITIVITY
effects of sensitization on, of microorganisms, 18: 33278 (STI/DOC/10/28(p.39-66))
genetic factors affecting, in mouse populations, 18: 33281(R) (TID-20844)
of adrenalectomized animals, effects of cortisone on, 18: 33404
of animal cells in culture, effects of DNA content on, 18: 33278 (STI/DOC/10/28(p.39-66))
of animal tissues, effects of oxygen concentration on, 18: 33404
of bacteria, effects of culture age and nucleic acid and protein contents on, 18: 33310
of bacteria, effects of freezing on gamma, 18: 33326
of bacterial spores, 18: 33278 (STI/DOC/10/28(p.39-66))
of bacterial spores, effects of freezing and postirradiation heating on, 18: 33996
of cassova nodes, 18: 33389
of conjugating Paramecia, 18: 33273(R) (NIRS-2(p.42-8))
of desoxyribonucleic acid, effects of 5-bromodeoxyuridine on, 18: 33402
of embryos, effects of ambient temperature on, in rats and mice, 18: 33423
of fetal liver in mice, 18: 33344
of lactobacilli, effects of culture conditions on, 18: 33293
of lysogenic system of *Staphylococcus albus*, 18: 33278 (STI/DOC/10/28(p.39-66))
of microorganisms, effects of DNA content on, 18: 33278 (STI/DOC/10/28(p.39-66))
of papaya seeds and young plants, 18: 33389
of rats, effects of energy balance on, 18: 33365
of seed, constant for predicting, 18: 33384
of tumor cells in mice, effects of oxygen tension, 18: 33379
of young mahogany trees, 18: 33389
prediction of mouse, using urine potassium-sodium ratios, 18: 33321
RADIOSTERILIZATION
of beef, effects on vitamin K_1, 18: 33992
of meat, parasite control in, 18: 33331
of strawberries, 18: 33993
of strawberries, 18: 33998
RADIOTHERAPY
book: *Physical Basis of Radiotherapy and Radiobiology*, 18: 33228
cobalt-60 rotational teletherapy, isodose distribution calculations for, 18: 33445
effects on heart pericardium, 18: 33327
of brain tumors, use of neutron capture in boron-10 for, 18: 33431 (TID-20856)
of cancer of cervix uteri, incidence of persistent or recurrent cancer, 18: 33444
of cancers, effects of AET on, 18: 33407
of cervical carcinomas, effects on estrogen and steroid excretion, 18: 33287
of head, injuries from, 18: 33422
of nervous system, necroses following, 18: 33290
of pelvic cancer, factitial proctitis induced by, 18: 33330
of pituitary tumors, effects of radiation on cranial bones, 18: 33338
of pleural effusion using gold-198, 18: 33439
of thyrotoxicosis, dose to medical personnel from, 18: 33421
of tumors, computer patient simulation for, 18: 33435
of uterine carcinomas, pathology of tissues after, 18: 33296
using intracavitary applicators, remote afterloading procedures for, 18: 33446
RADIUM
determination of body burden of, by radon measurements on breath, 18: 33262
measurement in industrial personnel, 18: 33424
separation from actinium-227 by ion exchange, 18: 35246(R) (MLM-1196)
RADIUM ISOTOPES Ra-226
content in man, method for determining, 18: 33821
determination in urine, 18: 33518
fission of, cluster-model, 18: 34872
use in ionization method for measuring contact potential differences, 18: 33863
RADIUM ISOTOPES Ra-228
analysis for thorium-232, by whole-body counting, 18: 33269
biological half life in liver and spleen, 18: 34274(R) (NIRS-2(p.3-15))
RADON
content in air near ground, beta counting method for determining, 18: 34257
determination of exhaled, in breath, 18: 33262
RADON ISOTOPES
range-energy curves of 6- to 12-Mev recoils of, in aluminum and aluminum oxide foils, 18: 34782 (UCRL-11563)
RADON ISOTOPES Rn-218
energy levels, 18: 34826
RADON ISOTOPES Rn-220
exhalation by Thorotrast patients, 18: 33425
RADON ISOTOPES Rn-222
half life, biological, 18: 33820
maximum permissible concentration in water, 18: 33820
RAIN WATER
radioisotope content of, gamma-emitting, 18: 33805(R) (NIRS-2(p.57-67))
RAMJET ENGINES
review on nuclear, 18: 35205
RAMJETS
radiation effects on telemetry electronics of, 18: 33838 (RTD-TDR-63-4287(Vol.I))
RARE EARTH ALLOYS
Mn–rare earth, preparation of amalgams for studies of, 18: 34028 (AD-430037)
RARE EARTH COMPLEXES
with oxalacetates, isotope effects on decarboxylation of, 18: 33598
RARE EARTH IONS
conversion of trivalent, in alkaline earth fluorides to stable divalent, 18: 33571
electron energy levels of, quadrupole antishielding factors for, 18: 34442
production of stable divalent, solid-state electrolytic process for, 18: 33589
RARE EARTH OXIDES
use in thermionic cell electrodes, 18: 34505(P)
RARE EARTHS
effects on thorium and zirconium, 18: 34053(R) (TID-20862)
magnetic ordering in heavy, temperature dependence of, 18: 34188
separation of cerium and yttrium groups, 18: 33689
RARE GASES
content in Renazzo chondrite, 18: 34390
electron drift velocities in, in electric fields, 18: 34322
solid state of, review on, 18: 34355
solubility in sodium, 18: 33678(R) (ANL-6875)
van der Waals forces for, 18: 34345
RATE METERS
auxiliaries, development of, for conversion of radiation count rate to color change, 18: 33968
RATS
amino acid metabolism in, tracer study of, 18: 33213 (STI/DOC/10/28(p.79-103))
antigenic composition of blood platelets in, 18: 33215(R) (TID-20824)
calcium–strontium discrimination by, effects of diet on, 18: 33805(R) (NIRS-2(p.57-67))
cerium-144 metabolism after intratracheal injection in, 18: 33252
deuterium oxide effects on, 18: 33250
effects of cerium-144 ingestion by pregnant, on growth and development of embryos, 18: 33352
hemoglobin and DNA synthesis in erythrocytes of, 18: 33234 (UCRL-11459)
immune reactions after temporary chimerism in irradiated, 18: 33387
iodine-131 uptake by blood plasma, liver, muscles, renal organs, and skin of, 18: 33251
iodine-131 uptake in, 18: 34403
lead absorption and excretion in, effects of EDTA on, 18: 33249
metabolism of thyroid hormones in, tracer study, 18: 33278 (STI/DOC/10/28(p.39-66))
mineral content of bones and teeth of normal and rachitic, effects of vitamin D on, 18: 33277 (STI/DOC/10/28(p.21-38))
phosphatide content and metabolism in irradiated and normal testes of, effects of ACTH and cortisone on, 18: 33256
phospholipid content in fatty livers of, 18: 33493
polonium removal from, effects of lagochylus on, 18: 33412
protein synthesis in thyroid of, effects of iodine metabolism on, 18: 33212(R) (NYO-2570-1)
radiation and burn injury effects on amino nitrogen, nonprotein, protein fractions, and serum protein contents in, 18: 33381
radiation and temperature on blood serum absorption and protein content in, 18: 33335
radiation effects on electrolyte distribution in blood of, gamma, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on adrenal cortex function in, x, 18: 33272(R) (NIRS-2(p.31-42))
radiation effects on connective tissue in, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on secretion of adrenalin and serotonin in, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on nucleic acid structure in liver cells of, 18: 33277

(STI/DOC/10/28(p.21-38))
radiation effects on nervous system in, 18: 33278 (STI/DOC/10/28(p.39-66))
radiation effects from deposited phosphorus-32 on metabolism in central nervous system of, 18: 33278 (STI/DOC/10/28(p.39-66))
radiation effects on embryos of, effects on post-natal physiological processes and adult pathology, 18: 33280(R) (TID-20831)
radiation effects on, proton, 18: 33286(T) (UCRL-Trans-1068)
radiation effects on nucleic acid synthesis in liver of, effects of partial-hepatectomy on, 18: 33294
radiation effects on potassium levels in regenerating liver of, x, 18: 33301
radiation effects on formation of lipid oxidation products in intestine, kidneys, and liver homogenates in, 18: 33305
radiation effects on, protective effects of physostigmine against, 18: 33306
radiation effects on cell growth in, 18: 33307
radiation effects on offspring of, 18: 33312
radiation effects on acetylcholine and sympathin content in brain of, effects of aminazine on, 18: 33325
radiation effects on Nissl granules in spinal cord neurons of, 18: 33349
radiation effects on electrophoretic distribution of blood serum proteins, 18: 33353
radiation effects on absorption in adrenal glands of, gamma, 18: 33357
radiation effects on desoxyribonuclease activity in, bremsstrahlung, 18: 33361
radiation effects on blood proteolysis in, x, 18: 33362
radiation effects on liver of, x, 18: 33380
radiation effects on lipid, nucleic acid, and protein synthesis in spleen of, 18: 33382
radiation effects on, therapeutic effects of splenectomy on, 18: 33415
radiation injuries of skin of, 18: 33340
radiation injuries in, protective effects of ACTH, 18: 33411
radiation protection of embryos of, 18: 33423
radiation sickness effects on lysine metabolism in calcified tissues in, 18: 33346
radiosensitivity of, effects of metabolism on, 18: 33365
testosterone and vitamin K, effects on irradiated-beef-fed, 18: 33992

REACTION MECHANISMS
of electron-transfer reactions in solution, 18: 33521 (BNL-8081)
use of tracer techniques in oxidation and solvolytic, analysis of, 18: 33985

REACTOR COMPONENTS
book: *Welding and Brazing Techniques for Nuclear Reactor Components*, 18: 34100
fabrication techniques, book on, 18: 34100
testing sheath tubes, ultrasonic, 18: 35153(R) (SRO-103)

REACTOR CONTROL ELEMENTS
design of cadmium-strip, 18: 35108(P)
development of boron-carbide-containing urania fuels, 18: 35126(R) (CEND-3107-216)

REACTOR CONTROL RODS
coupling to drive, design of releasable, 18: 35094(P)
drive mechanism for, design of hydraulic, 18: 35110(P)

REACTOR CONTROL SYSTEMS
design of EGCR, analysis of, 18: 35163 (TID-20890)
design of SILOE, 18: 35227

REACTOR COOLANTS
chemistry of cooling water in BORAX-V PSH-1, 18: 35060(R) (ANL-6904)
preparation of hydrocarbon, from aromatic catalytic cycle stock extract, 18: 33616(P)
pyrolysis and radiolysis of low-melting organic, 18: 33617 (AECL-1915)

REACTOR COOLING SYSTEMS
coolant blower and temperature controller in EGCR, analysis of, 18: 35164 (TID-20891)
corrosion inhibition in, by phosphate-delayed chromate method, 18: 35063 (IG-Report-52)
design of BWR test loop, 18: 35090(T) (ANL-Trans-52)
heat transfer and maximum temperature in Magnox, 18: 35182
natural circulation in multicircuit, transient regimes of, 18: 35081

REACTOR ENGINEERING
catalog of particulate-fueled reactor concepts, 18: 35119 (ANL-6892)
conference on noise analysis in nuclear systems, 18: 35069 (TID-7679)
design of reactor with moderator flowing inside closed tubes, 18: 35085(P)
review of, 1963, 18: 35159 (TID-8540)
zero-power-reactor transfer functions, 18: 35115

REACTOR FUEL ELEMENTS
analysis of irradiated, for uranium-235 and plutonium content, alpha spectroscopic, 18: 35065 (STI/DOC/10/28(p.67-71))
articulation of, mechanism for, 18: 35087(P)
boiling burnout studies on "nuclear vapotron", 18: 34090(T) (EURAEC-1015)
cladding materials behavior in steam and water environments, 18: 34076 (TID-8540(p.213-330))
coating by impurities from organic coolants, mechanism of, 18: 33667
design and fabrication of, 18: 35137(P)
design for gas-cooled reactors, 18: 35136(P)
design of assembly, for gas-cooled reactors, 18: 35134(P)
design of canned, for prevention of can distortions, 18: 35133(P)
design of plate assembly for liquid metal-cooled reactors, 18: 35132(P)
design of plate assembly with consumable poison, for swimming-pool reactors, 18: 35231(P)
dissolution of clad, one-step process for, 18: 33691(P)
fabrication of fissia, 18: 35146(R) (GEAP-4601)
fabrication techniques for uranium, 18: 34085(R) (BRB-81)
fission distribution in seven-pin cluster, 18: 35131
handling machine design, 18: 35095(P)
handling system design, 18: 35098(P)
heat transfer and maximum temperature in Magnox, 18: 35182
heat transfer characteristics of 19-rod bundles, 18: 35153(R) (SRO-103)
heat transfer in rod-bundle, from transition boiling, 18: 33734(R) (GEAP-4646)
loading of, channel plug design, 18: 35107(P)
loading with powder, vibrational method for, 18: 34118(P)
mechanical and thermal properties of beryllia-base, 18: 34040(R) (GEMP-36A)
meltdown in EBR-II-like reactors, coherence calculations of, 18: 35059 (ANL-6844)
positioning devices for, design of remote-control, 18: 35146(R) (GEAP-4601)
processing of irradiated by melt refining and skull reclamation, 18: 33678(R) (ANL-6875)
processing of irradiated, by fluoride volatility process, 18: 33678(R) (ANL-6875)
processing of irradiated, developments in, 18: 35247(R) (NAA-SR-9700)
processing of uranium–zirconium alloy, precipitation of fluoride and zirconium from dissolver solutions in, 18: 33690(P)
production of plutonium- and uranium-bearing, 18: 35130(T,R) (EURAEC-992)
radiation effects on metallic fast, 18: 35060(R) (ANL-6904)
shipping of spent, development of casks for, 18: 33822
storage of irradiated, plant for, 18: 33725(P)
testing of VSR, out-of-pile, 18: 35144 (GEAP-4560)
testing segmented-oxide-tube, in HWCTR, 18: 35153(R) (SRO-103)

REACTOR FUEL ELEMENTS (CERAMIC)
burnup testing of Zircaloy-2-clad uranium dioxide, 18: 35127(R) (GEAP-3771-13)
design and fabrication of stainless steel- and Zircaloy-2-clad plutonium dioxide–uranium dioxide, 18: 34049(R) (NUMEC-P-106)
design and fabrication of molybdenum–uranium dioxide cermet, for irradiation tests, 18: 34086 (GEAP-4435)
design of mixed-oxide, for test purposes, 18: 35146(R) (GEAP-4601)
design of uranium dioxide pellet-stainless steel sheathing, for high-temperature operation, 18: 35135(P)
development and testing of plutonia–urania, 18: 35146(R) (GEAP-4601)
development of urania, containing boron carbide, 18: 35126(R) (CEND-3107-216)
fabrication of uranium dioxide, by vibratory compaction, 18: 34096
fabrication of urania-tube, for heavy water reactors, 18: 35143(R) (DP-915)
neutron cross sections of, computer analysis of, 18: 35146(R) (GEAP-4601)
processing sintered uranium dioxide, method for, 18: 33692(P)
radiation effects on, 18: 35060(R) (ANL-6904)
radiation effects on multicomponent tubular uranium dioxide, 18: 35129 (HW-80291)
reactivity temperature coefficients of plutonia–urania, 18: 35114(T) (ORNL-tr-263)
thermal stress resistance of beryllium oxide, evaluation of, 18: 34166

REACTOR FUEL ELEMENTS (DISPERSION)
development of graphite-matrix, 18: 34032(R) (BMI-1668(Del.))
fabrication of aluminum-clad aluminum–uranium oxide plates, for ATR, 18: 34087 (ORNL-3644)
fabrication of stainless steel–uranium dioxide plates by rolling, 18: 34088 (ORNL-3645)
processing graphite-matrix, containing ceramics and coated particles, 18: 33687
reprocessing of graphite–uranium, study of combustion in fixed or moving bed for, 18: 33682 (ORNL-P-200)

REACTOR FUEL ELEMENTS (THERMOELECTRIC)

development for space power systems, status of, 18: 34001
development of, review of, 18: 34499
REACTOR FUEL PINS
design of sodium-bonded plutonia–urania, 18: 35146(R) (GEAP-4601)
REACTOR FUEL PLATES
fabrication of aluminum-clad aluminum–uranium oxide dispersion, for ATR, 18: 34087 (ORNL-3644)
fabrication of stainless steel–uranium dioxide dispersion, by rolling, 18: 34088 (ORNL-3645)
meltdown in SPERT I, analysis of, 18: 35220 (IDO-16883)
REACTOR FUEL RODS
analysis for uranium-235, statistical method for evaluating counting data in nondestructive, 18: 34044 (NAA-SR-9600)
development of urania, containing boron carbide, 18: 35126(R) (CEND-3107-216)
heat transfer characteristics of 19-rod bundles, 18: 35153(R) (SRO-103)
REACTOR FUEL SPHERES
fabrication of glass micro-, for homogeneous reactors, 18: 35138(P)
REACTOR FUEL TUBES
fabrication of urania, for heavy water reactors, 18: 35143(R) (DP-915)
testing sheath tubes, ultrasonic, 18: 35153(R) (SRO-103)
REACTOR FUELS
compaction of powdered, vibrational, 18: 34118(P)
cycle costs for, effects of production capability scale-up on, 18: 35151 (ORNL-TM-564)
development for fast reactors, 18: 35060(R) (ANL-6904)
development of cermet, 18: 34032(R) (BMI-1668(Del.))
development of coated-particle, 18: 34032(R) (BMI-1668(Del.))
development of coated-particle, 18: 34033(R) (BMI-1669(Del.))
development of coated-particle, 18: 34034(R) (BMI-1672(Del.))
fission product release from coated-particle, 18: 34033(R) (BMI-1669 (Del.))
fission product release from coated-particle, 18: 34034(R) (BMI-1672 (Del.))
neutron cross sections of ceramic, computer analysis of, 18: 35146(R) (GEAP-4601)
preparation and properties of plutonium dioxide–uranium dioxide, 18: 34049(R) (NUMEC-P-106)
preparation of silicon carbide–uranium silicide–stabilizer mixtures as, 18: 34071(P)
processing for fast reactors, 18: 35060(R) (ANL-6904)
processing of, pyrometallurgical processes for, 18: 33683 (TID-8540 (p.411-76))
processing sintered uranium dioxide, method for, 18: 33692(P)
radiation effects on coated-particle, 18: 34032(R) (BMI-1668(Del.))
radiation effects on coated-particle, 18: 34033(R) (BMI-1669(Del.))
radiation effects on coated-particle, 18: 34034(R) (BMI-1672(Del.))
recycling in plutonium–uranium fueled light-water-moderated reactors, 18: 35128(R) (GEAP-4642)
recycling mixed-oxide, effects of plutonium recycling schemes on, 18: 35146(R) (GEAP-4601)
review of metallic, 18: 34130 (TID-8540(p.331-410))
sampling irradiated, using ultrasonic microsampling techniques, 18: 35146(R) (GEAP-4601)
REACTOR FUELS (FUSED SALTS)
analysis of MSRE, for impurities, 18: 34050(R) (ORNL-3626(p.59-164))
performance of chloride mixtures as, 18: 34050(R) (ORNL-3626(p.59-164))
performance of fluoride mixtures as blanket, 18: 34050(R) (ORNL-3626 (p.59-164))
radiation effects on solidified, 18: 34050(R) (ORNL-3626(p.59-164))
radiolysis of fluoride, in-pile, 18: 34050(R) (ORNL-3626(p.59-164))
REACTOR MATERIALS
corrosion in reactor environment, bibliography on, 18: 34036 (CEA-Bib-16)
development for molten-salt reactors, 18: 35064(R) (ORNL-3626)
REACTOR MATRICES
fast fission factors in slightly enriched light water-moderated slab lattices, 18: 35117
neutron lifetimes in heavy water-moderated and -reflected, prompt, 18: 35116
neutron parameters for heavy water-moderated, calculational methods for, 18: 35112 (RISÖ-81)
neutron resonance integrals in, effect of effective lattice surface on calculation of, 18: 34744
physics measurements for water-moderated slightly enriched, 18: 35113 (TID-8540(p.529-609))
physics of heavy-water, review on, 18: 35120
reactivity temperature coefficients in heterogeneous, transport theory calculations of, 18: 35118
REACTOR MODERATORS
design of graphite block structure for gas-cooled reactors, 18: 35096(P)
neutron distribution in hydrogenous, second spatial moment of, 18: 34736
neutron transport in organic, 18: 34734
support of graphite core within concrete pressure vessel, 18: 35101(P)
support structure for vertical stack of graphite blocks, 18: 35100(P)
supporting post for periphery of, 18: 35097(P)
use of granular graphite as, 18: 35123(P)
REACTOR SAFETY
analysis of, for oxide-fueled fast cores, 18: 35146(R) (GEAP-4601)
design concepts and objectives in, 18: 35121
electronic trip device design for operation with ionization-chamber microammeter, 18: 33826 (DP-897)
excursions in water-cooled heterogeneous reactors, 18: 35068(R) (STL-6312)
fuel element meltdown failure in EBR-II-like reactors, calculations of coherence of hypothetical, 18: 35059 (ANL-6844)
hazards analysis of MSRE, 18: 35152 (ORNL-TM-732)
in merchant vessels, 18: 35209
research programs on, 18: 33678(R) (ANL-6875)
research programs on, 18: 35247(R) (NAA-SR-9700)
review, 18: 35180
REACTOR SAFETY EXPERIMENTS
development of TREAT sodium loop, 18: 35060(R) (ANL-6904)
excursions in KEWB and SPERT-ID, analysis of, 18: 35223(R) (STL-372-6)
excursions in SPERT-I, analysis of, 18: 35068(R) (STL-6312)
fission product release from uranium carbide in TREAT, 18: 35247(R) (NAA-SR-9700)
fuel element meltdown in SPERT I, analysis of, 18: 35220 (IDO-16883)
fuel element reactions with water in TREAT, 18: 33678(R) (ANL-6875)
reactions of aluminum alloys with water, TREAT studies of, 18: 35060(R) (ANL-6904)
reactions of Zircaloy-2-clad uranium dioxide fuel pins with water, TREAT studies of, 18: 35060(R) (ANL-6904)
REACTOR SHIELDING
design for protection of pressure vessels from hot coolants and neutron beams in gas-cooled reactors, 18: 35109(P)
design for reduction of induced radioactivity in air between biological shield and pressure vessel, 18: 35103(P)
physics of, problems in, 18: 35091(T) (JPRS-25467)
properties of concretes, 18: 35092(T) (JPRS-25467(p.1-8))
REACTOR SLURRIES
preparation of hydrothermally stable sols of plutonia, thoria, and urania, 18: 33609(P)
solids for, fabrication of glass-coated, 18: 35138(P)
REACTOR SOLUTIONS
purification in circuit of homogeneous reactor, 18: 35084(P)
REACTOR TUBES
fabrication of inconel-monel, method for, 18: 35093
plug design for pressurized, 18: 35107(P)
thermal stress analysis of zirconium–carbon steel scarf joint, 18: 33694 (HW-76850)
REACTORS
by-products from, 18: 33984 (TID-8540(p.477-528))
Chebyshev coefficients, 18: 35060(R) (ANL-6904)
control by articulation of fuel elements, mechanism for, 18: 35087(P)
control by rotation of fuel units with fertile and moderator sectors, 18: 35086(P)
control element design for, stationary cadmium-strip, 18: 35108(P)
Doppler effect in, weighting factor effects on, 18: 35060(R) (ANL-6904)
gamma and neutron dosimetry in, review of methods for, 18: 33879 (HW-SA-3585)
gamma reactions with materials in, heat generation from, 18: 34236
instrumentation of, technology review of in-pile, 18: 35089 (TID-8540 (p.177-211))
loading and unloading of, transfer device for, 18: 35095(P)
loading and unloading machine, 18: 35098(P)
neutron density fluctuations during zero-power excursions, equations for, 18: 35080 (TID-7679(p.347-55))
neutron multiplication in, stochastic models for, 18: 35070 (TID-7679 (p.29-59))
neutron spectra in, measurement of deviation from 1/E distribution in epicadmium, 18: 34735
neutron spectra measurements in operating, 18: 35066 (STI/DOC/10/28 (p.73-7))
noise analysis of, digital data reduction for, 18: 35077 (TID-7679 (p.301-5))
noise measurements for, equipment and techniques for, 18: 35071 (TID-7679(p.107-33))
propulsion systems using, 18: 35205
reactivity measurements for, use of spectral density of neutron fluctuations for negative, 18: 35074 (TID-7679(p.171-81))

reactivity measurements using source excitation and correlation techniques for, 18: 35076 (TID-7679(p.219-28))
reactivity of, cross-correlation techniques with random source excitation for, 18: 35075 (TID-7679(p.203-18))
reactivity temperature coefficients in mixed-oxide fueled, 18: 35114(T) (ORNL-tr-263)
shutdown reactivity measurements using noise techniques, 18: 35072 (TID-7679(p.135-54))
temperature measurement in, quartz crystal-oscillator circuit for, 18: 33872(P)
transfer function of zero-power, 18: 35115
transfer functions from fission chamber pulse sampling by periodic-reactivity-modulation method, 18: 35079 (TID-7679(p.331-4))
transfer functions for, use of power spectra in reactor-system analysis of, 18: 35071 (TID-7679(p.107-33))

RECOIL IONS
energy transfer in Szilard-Chalmers reactions, review on theory of, 18: 33660

REDOX PROCESS
waste calcination and solidification, development of equipment and techniques for, 18: 35234(R) (HW-81862)

REFLECTOR MODERATED REACTORS
design with horizontal beam tube, 18: 35232(P)

REFRACTORY MATERIALS
analysis of, book, 18: 33474(T) (FTD-TT-63-814)
book: *Analysis of High-Melting Compounds*, 18: 33474(T) (FTD-TT-63-814)
coatings for, cementation, 18: 34091
conference on composites, 18: 34037 (DMIC-Memo-192)
deposition on graphite, 18: 34116(P)
fabrication of sheets of, methods and problems of, 18: 34103
flow forming of, for rocket engine techniques, 18: 34109
forging in hydraulic presses, closed-die, 18: 34105
machining of, problems in, 18: 34106
properties for use at high temperatures, 18: 34201
properties of ceramic, handbook on, 18: 34129 (RTD-TDR-63-4102 (Suppl.1))
sheet forming of, problems in, 18: 34107
status of, for space vehicle thermal protection, 18: 34062
welding of, electron-beam and tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
welding of, electron beam, 18: 34092

REFRIGERATION
analysis of cycles of, for cooling cryogenic magnets, 18: 34682(R) (NBS-8407)

RELATIVITY THEORY
geodesic equations of motion in general, finite-mass particles in, 18: 34335
independence of light and source velocities, 18: 34294
photon rockets in, motion equations for, 18: 34649
quaternion formalism in, 18: 34667

RELAYS
hysteresis of thyratron, 18: 33845(T) (AEC-tr-6399(p.21-9))
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))

REMOTE-CONTROL EQUIPMENT
design for handling and canning fuel elements, 18: 35098(P)
design of extensible-retractable manipulator arm, 18: 33723(P)
design of manipulator with extensible-retractable arm, 18: 33724(P)
design of mechanical manipulator for sealed enclosures, 18: 33722(P)
design of pneumatic gripping tong for rapid repair, 18: 33726(P)
design of radial adjustment mechanism for fuel elements, 18: 35146(R) (GEAP-4601)
design of transfer device for handling fuel elements in reactors, 18: 35095(P)
development of master-slave manipulator, 18: 35060(R) (ANL-6904)
for volumetric dispenser of liquid radioisotopes, 18: 33653

RENÉ-41
properties of foils at high temperatures, mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)

REPTILES
radiation effects on biological activity of venom of *Ancistrodon piscivorus*, 18: 33385

RESEARCH REACTORS
construction and design of, at Islamabad, Pakistan, 18: 35229
control system of SILOE, 18: 35227
design of Hitachi pool-type, 18: 35224
design with horizontal beam tube, 18: 35232(P)
fission product buildup and decay in, iodine and tellurium, 18: 35228
noise analyses of Japanese, 18: 35073 (TID-7679(p.155-69))
research and training at IRR-1, 18: 35219 (IA-894)
research program at IRR-1, 18: 35218 (IA-892)
use in development and evaluation of power plants, 18: 35148 (IA-891)

RESERPINE
radiosensitivity effects on fish, x, 18: 33272(R) (NIRS-2(p.31-42))

RESINS
radiation effects on, handbook on, 18: 34245
uptake of iodine-131-labeled triiodothyronine, 18: 33437

RESISTORS
radiation and environmental effects in space, 18: 34235
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))

RESORCINOL
analysis for active hydrogen by NMR spectroscopy, 18: 33475

RHENIUM
bibliography on preparation, fabrication, and uses of, 18: 34151
effects on tantalum–tungsten alloys, 18: 34059(R) (WANL-PR(Q)-003)
neutron capture cross sections, 18: 33678(R) (ANL-6875)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
neutron total cross sections, 18: 33678(R) (ANL-6875)
properties as diffusion barrier for refractory metals, 18: 34029(R) (AD-601740)

RHENIUM ALLOY COUPLES
Re–W/Re–W, thermocouple drift at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)
Re–W/W, thermocouple drift at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)

RHENIUM ALLOYS
Cr–Re, nitrogen interstitials in, internal-friction studies of, 18: 34032(R) (BMI-1668(Del.))
Cr–Re, nitrogen interstitials in, internal-friction studies of, 18: 34033(R) (BMI-1669(Del.))
Cr–Re, nitrogen interstitials in, internal-friction studies of, 18: 34034(R) (BMI-1672(Del.))
Fe–Mo–Re, electric conductivity at 1.5 to 77°K, 18: 34183
Mo–Nb, electric conductivity at 1.5 to 77°K, 18: 34183

RHENIUM CARBONYLS
$(CO)_5Mn–Re(CO)_5$, spectra of, infrared, 18: 33551

RHENIUM COUPLES
Re/W, compatibility with plutonia–urania systems, 18: 35146(R) (GEAP-4601)

RHENIUM ISOTOPES Re-186
decay, 18: 34805

RHENIUM ISOTOPES Re-187
gamma transitions in, electron spectra from, 18: 34804

RHENIUM OXIDES
catalytic effects on radioinduced polymerization of solid 3,3-*bis*-chloromethyloxatane, 18: 33651

RHODIUM
carbon-12 reactions (C-12,C-11) at 10 Mev, differential cross sections for, 18: 34951
fluorine-19 reactions (F-19,F-18) at 10 Mev, differential cross sections for, 18: 34951
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
nitrogen-14 reactions (N-14,N-13) at 10 Mev, differential cross sections for, 18: 34951
oxygen-15 reactions (O-15,O-16) at 10 Mev, nucleon stripping in, 18: 34951
oxygen-16 reactions (O-16,O-15) at 10 Mev, differential cross sections for, 18: 34951
oxygen-16 reactions (O-16,F-18) at 10 Mev, differential cross sections for, 18: 34951

RHODIUM ALLOY COUPLES
Pt/Pt–Rh, thermocouple drift at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)
Pt–Rh/Pt–Rh, thermocouple drift at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)

RHODIUM ISOTOPES Rh-103
proton reactions (p,n) at 7 to 13 Mev, 18: 34859

RHODIUM ISOTOPES Rh-106
determination in liquids, gamma spectrometric, 18: 33485

RIBONUCLEASE, DEOXY-
radiation effects on activity of rat, bremsstrahlung, 18: 33361

RIBONUCLEIC ACID
radiation effects on structure of, in biological systems, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on synthesis in rat liver, 18: 33294
radiosensitivity effects on Saccharomyces x, 18: 33410

synthesis of, enzyme systems for, 18: 33243
synthesis of, enzyme systems for, 18: 33244
synthesis of, enzyme systems for, 18: 33245
RIBONUCLEIC ACID, DESOXY-
effects of content of, on radiosensitivity of microorganisms and animal cells in culture, 18: 33278 (STI/DOC/10/28(p.39-66))
effects on radiosensitivity of bacteriophage, 18: 33278 (STI/DOC/10/28 (p.39-66))
incorporation of 5-bromouradine by, 18: 33212(R) (NYO-2570-1)
isolation of, from *E. coli*, 18: 33275(R) (NYO-910-2)
labeling for cell life-cycle analysis, 18: 33226
metabolism at cellular level, tracer study, 18: 33253
protective effects of isologous and homologous, against radiation injuries, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on, effects of oxygen on, 18: 33273(R) (NYO-910-2)
radiation effects on structure of, in biological systems, 18: 33277 (STI/DOC/10/28(p.21-38))
radiation effects on synthesis in rat liver, 18: 33294
radiation effects on thymine dimer excision from *E. coli*, uv, 18: 33298
radiation effects on synthesis of, in regenerating rat liver, x, 18: 33301
radiation effects of pea, gamma, 18: 33356
radiosensitivity of, effects of 5-bromodeoxyuridine on, 18: 33402
synthesis of, in rat erythrocytes and precursors, 18: 33234 (UCRL-11459)
RIBONUCLEOTIDES
antigenic properties of, 18: 33222
reactions with bovine serum albumin, immune, 18: 33247
RIBONUCLEOTIDES, DESOXY-
radiation effects on liberation from tissues, 18: 33308
ROCKET MOTOR NOZZLES
analysis of uncooled, feasibility, 18: 33707
development of tungsten, process of, 18: 34105
ROCKET MOTORS
design of, using radioisotope heating, 18: 34003
fluid flow and thermal analysis on NERVA, computer program for, 18: 33751
ion engine ground testing technique development, 18: 34261 (AEDC-TDR-64-127)
ROCKET REACTORS
analysis of, for lunar mission, 18: 35210
development of, review of, 18: 35178
development status, 18: 35216
mission-weight analysis, 18: 35214
reactivity variations in, during startup, 18: 35213
review, 18: 35205
ROCKET REACTORS (KIWI)
development status, 18: 35216
ROCKETS
analysis of chemical, for lunar mission, 18: 35210
motion equations for photon, in general relativity, 18: 34649
uses of nuclear, 18: 35214
ROCKS
age estimation by argon–krypton and rubidium–strontium methods, 18: 33781
analysis for cesium by flame photometry, 18: 33500
analysis for sulfur-32 ratio with sulfur-34 in, 18: 33501
radiation effects on optical properties of powdered, solar, 18: 34392
RODS
heat transfer between separated bunches of, with longitudinal flow of liquid sodium, 18: 33744
heat transfer to, a transition boiling channel flow, 18: 33734(R) (GEAP-4646)
RUBBER
neutron scattering in, at 4 to 11 Å, 18: 34752(R) (CU(PNPL)-234)
permeability of butyl and neoprene, to oxygen and water vapor, 18: 34058(R) (WANL-PR(P)-003)
sorptive properties of neoprene for young fission products from solutions, 18: 33448 (IDO-14644)
RUBIDIUM
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
properties as reactor working fluid, 18: 35198 (NAA-SR-8617(Vol.I))
RUBIDIUM CHLORIDES
radiation effects on optical absorption of F and K bands in, 18: 34306
RUBIDIUM IODIDES
scintillation processes in crystals of, 18: 33636
RUBIDIUM ISOTOPES
redistribution during metamorphism in Panamint Range, California, 18: 33793
RUBIDIUM ISOTOPES Rb-84
beta decay of, first-forbidden, 18: 34874
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
RUBIDIUM ISOTOPES Rb-86
beta decay of, first-forbidden, 18: 34874
beta decay theory for, 18: 34752(R) (CU(PNPL)-234)
determination of physico-chemical state in liquid media, by paper electrophoresis and radioactivity recording, 18: 33590
RUTHENIUM
determination in sea water by ion exchange on ferric, hydroxide resin, 18: 33449(R) (NIRS-2(p.15-19))
determination of, spectrophotometric, 18: 33678(R) (ANL-6875)
separation from nitric acid waste solutions by electrodeionization and electrodialysis, 18: 35234(R) (HW-81862)
RUTHENIUM CARBIDES
preparation of, conditions for, 18: 33572
RUTHENIUM ISOTOPES Ru-102
energy levels of, measurement of lifetime of first excited, 18: 34772 (NP-14184)
RUTHENIUM ISOTOPES Ru-103
content in fallout in French Territory, 18: 33770 (SCPRI(S)-99)
determination in liquids, gamma spectrometric, 18: 33485
determination in urine and feces of, gamma spectrometric, 18: 33264
RUTHENIUM ISOTOPES Ru-106
content of, in fish in Irish Sea, 18: 33248
determination in liquids, gamma spectrometric, 18: 33485
gamma spectra of, least-squares analysis of, 18: 33926
RUTHENIUM OXIDES
separation from air by sodium hydroxide scrubber, 18: 34006(R) (ORNL-TM-889)
RUTILES
transformation to anatase, mechanism, 18: 35253 (UCRL-11001)

S

SAFETY
in handling gaseous and liquid hydrogen, development of room inerting system for, 18: 33804 (LADC-6432)
in nuclear materials management, 18: 33799 (CONF-620-2)
procedures in radiation accidents, 18: 33817
SAMARIUM
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
separation from thorium and uranium by paper chromatography, 18: 33505
SAMARIUM ALLOYS
Mn–Hg–Sm, preparation of amalgams of, 18: 34027 (AD-428772)
Mn–Sm, amalgam studies, 18: 34026 (AD-428771)
SAMARIUM ARSENIDES
electric properties and uses of, 18: 34158
SAMARIUM ISOTOPES Sm-144
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
SAMARIUM ISOTOPES Sm-147
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
SAMARIUM ISOTOPES Sm-148
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
SAMARIUM ISOTOPES Sm-149
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
SAMARIUM ISOTOPES Sm-150
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
SAMARIUM ISOTOPES Sm-152
energy levels of, collective, 18: 34913
energy levels of, vibration-rotation interactions in, 18: 34846
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
nuclear vibrational-rotational interactions in, 18: 34950
SAMARIUM ISOTOPES Sm-154
energy levels of, collective, 18: 34913
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
SAMARIUM OXIDES
Sm_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Sm_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199

SAMARIUM SYSTEMS
Sm–H_2O, neutron spectra in, 18: 34733
SAMPLING
methods for taking microsamples of irradiated fuel cores, using ultrasonics, 18: 35146(R) (GEAP-4601)
SAP (SINTERED ALUMINUM PRODUCTS)
creep rupture testing at 800 to 1000°F, 18: 35153(R) (SRO-103)
creep-rupture at 700 to 900°F, long-term, 18: 34032(R) (BMI-1668(Del.))
creep-rupture at 700 to 1000°F, long-term, 18: 34034(R) (BMI-1672(Del.))
creep-rupture at 700 to 1000°F, long-term, 18: 34033(R) (BMI-1669(Del.))
microstructure of annealed and ion bombarded foils of, 18: 34038 (EUR-1833.e)
SAPPHIRES
thermal resistance at normal and superconducting indium boundaries with, at 1.1 and 2.1°K, 18: 34699
SATELLITES
control of, ion engine systems for, 18: 33699
design and development of Navigator, 18: 35197(R) (64SD700)
electric power system for SYNCOM 2, 18: 33700
instrumentation for measurement of auroral phenomena, 18: 33935
SAVANNAH RIVER COMPONENTS TEST REACTOR
operations, 18: 35143(R) (DP-915)
operations, 18: 35153(R) (SRO-103)
SAXTON POWER REACTOR
noise measurements for, 18: 35156 (TID-7679(p.427-47))
SCALERS
design and development of, summary, 18: 34752(R) (CU(PNPL)-234)
design of automatic, 18: 33884 (RT/EL(64)-7)
development of 50 Mc decade, 18: 33956
modifications to, for rate studies, 18: 33868
SCANDIUM
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
properties and structure of monocrystals, 18: 34147
SCANDIUM ISOTOPES Sc-42
energy level population in (α,d) reactions, 18: 34779 (UCRL-11341)
energy levels, 18: 34960
SCANDIUM ISOTOPES Sc-43
energy levels of, lifetime of $d_{3/2}$ hole, 18: 34923
SCANDIUM ISOTOPES Sc-44
production of isomer pairs of, in heavy ion reactions, 18: 34948
SCANDIUM ISOTOPES Sc-45
energy levels of, lifetime of $d_{3/2}$ hole, 18: 34923
neon-22 reactions at 60 to 160 Mev, production of scandium-44 isomer pairs in, 18: 34948
oxygen-16 reactions at 20 to 80 Mev, production of scandium-44 isomer pairs in, 18: 34948
SCANDIUM ISOTOPES Sc-46
beta decay of, angular correlations in, 18: 34752(R) (CU(PNPL)-234)
SCANDIUM ISOTOPES Sc-47
energy levels of, lifetime of $d_{3/2}$ hole, 18: 34923
SCANDIUM OXIDES
Sc_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Sc_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
SCATTERING
amplitude and diffraction peak in, unitarity bounds on, 18: 34560
amplitudes for three-body, with complex total angular momentum, 18: 34518 (UCRL-11546)
amplitudes of, with unstable particles, 18: 34605
bootstrap calculations on, approximation method for, 18: 34562
boundary condition for nonrelativistic Schrödinger equation, outgoing-wave, 18: 34597
endpoint method generalization for, 18: 35056
fermion Regge trajectories for nucleon-pseudoscalar meson interactions in, 18: 34558
Feynman diagrams for, properties of Landau curves of, 18: 34668
into rearranged channel, coupled equations for, 18: 34643
phase shifts for electron, on screened Coulomb potential, 18: 34528
phase shifts for nucleon-nucleon, singlet-state, 18: 34546
potentials for many-channel s-wave, Bargmann, 18: 34532
potentials in, phase-shift determination of, 18: 34635
Regge pole analysis of three-body, difficulties in, 18: 34518 (UCRL-11546)
s-matrix analyticity for singular potentials in, 18: 34637 (NP-14076)
solutions of symmetric Dirac–Coulomb hamiltonian, 18: 34576
theory of, local operators in s-matrix, 18: 34541
SCINTILLATION
collection of carbon dioxide for, design of vial reaction tube for, 18: 33478
SCINTILLATION DETECTORS
calibration for slow neutrons for measuring water content in leda clay, 18: 33897
camera using multichannel collimators with, 18: 33940
conference on, 18: 33900
design and development of, summary, 18: 34752(R) (CU(PNPL)-234)
design for antineutrino reactions, 18: 33901
design for detecting beta particles emitted from movable member, 18: 33976(P)
design of liquid, for thermal neutrons, 18: 33953
development for auroral phenomena, 18: 33935
development for uv radiation, 18: 33908
development of low-background, for alpha particles, 18: 33933
development of, for visualization of isotope distribution on colored scintigrams, 18: 33968
efficiency for copper Kα emission, 18: 33896
efficiency of, in extended gamma fields, 18: 33941
electron photoproduction in, energy for, 18: 33860
performance evaluation of, computer program for, 18: 33232(R) (NYO-910-3)
performance for carbon-14 and tritium counting, evaluation of various solvents for, 18: 33938
performance for gamma spectra, compensation for instabilities in, 18: 33926
performance for gamma detection, effects of additions of organometallic compounds to plastics on, 18: 33939
performance in time-of-flight neutron spectrometers, 18: 34752(R) (CU(PNPL)-234)
pulse-height spectra of, analysis of, 18: 33925
review, 18: 33967
stabilization circuits for, 18: 33934
use in absolute beta measurement in layered preparations, 18: 33659
use in high-level whole-body counter, 18: 33937
use of liquid, for biological and medical research, 18: 33220
use of 4π, for absolute activity measurement of beta sources, 18: 33946
use with light pipes in radiometric instruments, 18: 33850(T) (AEC-tr-6399(p.163-72))
SCRUBBERS
development for ruthenium tetraoxide in air, 18: 34006(R) (ORNL-TM-889)
SEA URCHINS
development of, effects of adenosine nucleotides on, 18: 33270(R) (NIRS-2(p.23-6))
SEA WATER
analysis for radioruthenium by ion exchange on ferric hydroxide resin, 18: 33449(R) (NIRS-2(p.15-19))
desalination of, development of nuclear power for, 18: 35178
SEALING MATERIALS
development and testing for space power systems, 18: 34046(R) (NASA-CR-54041)
radiation effects on O-rings, 18: 33839 (RTD-TDR-63-4287(Vol.II))
SEALS AND GLANDS
design for two tubular elements, 18: 33708(P)
design of low-temperature, for plastic window, 18: 34685
development for nuclear space propulsion systems, 18: 35216
plug design for pressurized reactor tubes, 18: 35107(P)
SEDIMENTATION
profile of North Atlantic, mineral and ionium/thorium analysis of, 18: 33790
SEED
radiation effects in cotton, 18: 33313
radiation effects on extracts of cellular structure of sugar beet leaves by exposure of, 18: 33314
radiation effects on cotton, gamma, 18: 33333
radiation effects on barley, combined with mutogens, 18: 33375
radiation effects on potato production of, x, 18: 33376
radiation effects on barley, effects of chlorides of calcium, magnesium, and sodium on, 18: 33409
radiosensitivity of, constant for predicting, 18: 33384
radiosensitivity of papaya, 18: 33389
SEISMOLOGY
discrimination of signals from earthquakes and explosions, auditory, 18: 33765 (AD-437784)
SELENIUM
activation by thermal neutrons, self-shielding effects in, 18: 33488
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination in biological materials, activation, 18: 33464 (NASA-CR-52997)
determination in silicon, activation, 18: 33502

neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))

SELENIUM ISOTOPES Se-77
energy level at 248 kev, g-factor for, 18: 34895

SEMICONDUCTOR DETECTORS
amplifiers for, design of cascode, 18: 33898
amplifiers for, development of low-noise charge-sensitive, 18: 33927
amplifiers for, development of low-noise vacuum-tube, 18: 33928
conference on, 18: 33900
development for fission fragments, 18: 33955
development for particle discrimination by time-of-flight methods, 18: 33932
development of high-temperature, for nuclear particles, 18: 33918
development of nuclear-compensated silicon n-i-p junction, 18: 33920
development of silicon junction, by ion implantation doping, 18: 33921
electric circuitry for multiple systems of, high-stability, modular, 18: 33936
electric field strength relations for silicon surface-barrier, 18: 33954
fission fragment detection in, multiplication in pulse-height response to, 18: 33915
performance of lithium-drifted diode, as gamma pair spectrometers, 18: 33912
performance of silicon, for electron spectrometry, 18: 34752(R) (CU(PNPL)-234)
proton channeling in silicon, at 2.1 Mev, 18: 33917
pulse amplification in silicon junction, internal, 18: 33959
pulse dividers for, design of high-speed analog, 18: 33929
radiation damage effects in lithium-drifted silicon, alpha, fast neutron, and proton, 18: 33913
radiation damage effects in lithium-drifted silicon, gamma, 18: 33914
response of surface-barrier, to fission fragments, 18: 33945
response to alpha and beta particles, temperature dependence of, 18: 33916
response to electrons, transient, 18: 33919
stabilization of lithium-drifted silicon junction, 18: 33922

SEMICONDUCTORS
nuclear dynamic polarization near paramagnetic impurity in, 18: 34334
radiation and environmental effects in space, 18: 34235
radiation effects on, fast-neutron and gamma, 18: 33825 (AD-435095)
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
radiation effects on thermoelectric properties of, 18: 34237
recombination of electrons and donors in, 18: 34280(R) (NYO-2680-1)

SEPARATION PROCESSES
development for treatment of irradiated fuel elements, 18: 35247(R) (NAA-SR-9700)
development of foam, 18: 34007(R) (ORNL-TM-890)

SEWAGE
radioactivity, 18: 33805(R) (NIRS-2(p.57-67))

SHEEP
lipid metabolism in, tracer studies on, 18: 33213 (STI/DOC/10/28(p.79-103))
strontium-90 content in bones of, 18: 33240

SHEETS
fabrication of refractory metal, methods and problems of, 18: 34103
forming of refractory metal, methods and problems of, 18: 34107

SHELLS
stress analysis of concentric spherical, under heating, 18: 33755

SHELTERS
communications systems of fallout, specifications of radio equipment for, 18: 33840 (TGGM-642)
design of simple bomb shelter, 18: 33758(P)

SHIELDED CONTAINERS
design with remotely operated shutter, 18: 33728(P)
development for shipping spent fuel, 18: 33822
neutron surface multiplication for, adjoint-problem solution for, 18: 34726 (AWRE-O-21/64)

SHIELDING
analysis of space-environment, computer, 18: 35048 (AMRL-TDR-64-11)
design for Cambridge Synchrotron, 18: 34367 (CEAL-1000)
design for ductwork in radiation facilities, 18: 35049
protective effects of, against radiation injuries in embryos of rats and mice, 18: 33423
slowing-down equation for, constant solution of, 18: 34747

SHIELDING MATERIALS
gamma transmission through cylinders and spheres of, Monte Carlo calculations for, 18: 35052
neutron removal cross sections for, 18: 34888
properties, 18: 35050
properties of, gamma and neutron counters and dosimeters for determining, 18: 33886(T) (IPRS-25467(p.9-24))
testing at Dubna proton synchrocyclotron, 18: 34374

SHIPPING
of spent fuel elements, development of casks for, 18: 33822

SHIPPINGPORT PRESSURIZED WATER REACTOR
operation, May 1964, 18: 35142(R) (DLCS-5000564)

SHOCK TUBES
electric current shortcircuiting in, snowplow model for, 18: 34330
magnetic flux transport by plasma in, 18: 35007
shock reflection against end plate in high-explosive, 18: 34332

SHOCK WAVES
book: *Magnetohydrodynamic Shock Waves*, 18: 34360
formation in gas-flow tube, kinetic theory of, 18: 34279 (NP-14186)
interactions with electromagnetic fields, magnetic field diffusion in, 18: 34333
ionization of argon normal, 18: 35042
ionization of gases by, far-flow approximations for precursor, 18: 34288
ionization of xenon by, impurity effects on, 18: 34361
measurement from 20-ton TNT charge on ground, 18: 34278 (NP-14174 (Vol.1))
motion of hydromagnetic ionizing fronts in cylindrical geometry, 18: 35009
propagation in plasma, theory for, 18: 35032
propagation in solids, measurement of front position of, 18: 34357
propagation of MHD, in plasma, 18: 35006
recording of, coaxial electric discharge pins for, 18: 33862
reflection against end plate in high-explosive tubes, 18: 34332
structure in discrete-velocity gas, 18: 34325
structure of plane, in plasma, 18: 34998

SILICATE ROCKS
analysis for cesium by flame photometry, 18: 33500

SILICIDES
deposition on D-14 niobium alloy, 18: 34052 (RTD-TDR-63-4063)
deposition on molybdenum and niobium, 18: 34209

SILICON
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
analysis for impurities, activation, 18: 33502
boron ion reactions with n-type, implantation doping from, 18: 33921
coating with neodymium and promethium compounds, 18: 34034(R) (BMI-1672(Del.))
contents in meteorites, 18: 34398
dislocations in, use of white x radiation for spectra of, 18: 34186
electric field strength relations for surface-barrier detectors of, 18: 33954
electroplating of p-type, with phosphorus-31, 18: 34005(R) (ORNL-TM-879)
fission fragment detection in surface barriers of, multiplication in pulse height response to, 18: 33915
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
neutron reactions (n,γ) with semiconducting, phosphorus-31 production in thermal, 18: 33920
nuclear dynamic polarization of phosphorus-doped, 18: 34334
proton channeling in crystals of, at 2.1 Mev, 18: 33917
radiation effects on defects in, 18: 34216 (NASA-TN-D-2364)
radiation effects on carrier lifetime in, effects of dosage and impurities on, 18: 34228
radiation effects on thermoelectric properties of, 18: 34237
radiation effects on oxygen-doped, infrared absorption bands in electron, 18: 34239
solubility in beta phase of cobalt–niobium alloys, 18: 34145
use in determining absolute scale of x-ray wavelengths, 18: 34340
x-ray scattering by crystals of, anti-Stokes and Stokes modified lines in, 18: 35242 (CALT-221-2)

SILICON CARBIDES
performance in nuclear particle detectors at high temperatures, 18: 33918
use in refractory fuel material, 18: 34071(P)

SILICON CHLORIDES
BCl_3–H–SiCl, reaction with boron–molybdenum–silicon systems, 18: 34146

SILICON ISOTOPES
separation of stable, in calutrons, 18: 34005(R) (ORNL-TM-879)

SILICON ISOTOPES Si-28
alpha reactions (α,γ) with, 18: 34924
energy levels, 18: 34822
gamma reactions (γ,p) up to 21 Mev, cross sections for, 18: 34901

SILICON JUNCTIONS
development for particle discrimination by time-of-flight methods, 18: 33932

development of nuclear-compensated, 18: 33920
electron reactions with detectors of p-n, internal pulse amplification in, 18: 33959
ion-pairing in lithium-drifted, 18: 33922
performance of lithium-drifted p-i-n, as gamma pair spectrometers, 18: 33912
production by ion implantation doping, 18: 33921
radiation damage effects in lithium-drifted p-i-n, alpha, fast neutron, and proton, 18: 33913
radiation damage effects in lithium-drifted p-i-n, gamma, 18: 33914
radiation damage in, single collision neutron, 18: 34248
response of lithium-drifted p-i-n, to alpha and beta particles, 18: 33916
response to electrons, transient, 18: 33919

SILICON NITRIDES
development as high-temperature radome material, 18: 34054 (UCRL-7795)
thermophysical properties, 18: 34054 (UCRL-7795)

SILICON OXIDES
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
effects on plutonium dioxide–uranium dioxide systems, 18: 34049(R) (NUMEC-P-106)

SILICON SYSTEMS
Al–C–Mo–Ni–Si–U–Zr, preparation and fabrication as refractory fuel material, 18: 34071(P)
Al–Cr–Si, coating processes for cementation on refractory metals, 18: 34091
B–Mo–Si, diffusion reactions in boron chloride–hydrogen–silicon chloride, 18: 34146
Cr–Si–Ti, coating processes for cementation on refractory metals, 18: 34091
Fe–Si, dislocation mobility in crystals of, 18: 34122(R) (GA-4900)
Mo–Si–W, deposition on D-14 niobium alloy, 18: 34052 (RTD-TDR-63-4063)
Si–V, radiation effects of neutrons on superconductivity of, 18: 34683(R) (NP-14136)

SILICONE RUBBERS
neutron scattering at 4 to 11 Å, 18: 34752(R) (CU(PNPL)-234)

SILICONES
hexamethylsiloxane, neutron scattering at 4 to 11 Å, 18: 34752(R) (CU(PNPL)-234)
tetramethylsilicone, neutron scattering at 4 to 11 Å, 18: 34752(R) (CU(PNPL)-234)

SILTS
sorptive properties for fission products in rivers, 18: 35238 (STI/DOC/10/28(p.9-20))

SILVER
activation by thermal neutrons, self-shielding effects in, 18: 33488
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
analysis for hydrogen, nitrogen, and oxygen, vacuum fusion, 18: 33491
beta scattering by, measurement of saturated backscattering from, 18: 35057
bromination of hydrosol of, development of highly sensitive nuclear emulsions by, 18: 33962
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
determination in biological materials, activation, 18: 33464 (NASA-CR-52997)
determination in pure uranium compounds by solvent extraction using dithizone, 18: 33509
determination in silicon, activation, 18: 33502
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
electron scattering by, energy loss mechanisms in relativistic, 18: 34258(R) (AD-417250)
gamma reactions (γ,n) with, neutron angular distribution from, 18: 34935
neutron elastic scattering cross sections of natural, 18: 35060(R) (ANL-6904)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
oxygen-16 reactions at 167 Mev, charged-particle emission in, 18: 34780 (UCRL-11349)
proton reactions at 2 to 9 Bev, fragment angular correlations for, 18: 34940
spectra of, x-ray L-absorption and -emission, 18: 34412
x-ray L-emission spectrum, 18: 34410
x-ray spectra of, precision redetermination of wavelength of Kα_1 line in, 18: 34341

SILVER CHLORIDES
electron trapping in crystals of, 18: 34280(R) (NYO-2680-1)

SILVER ISOTOPES Ag-106
conversion electron spectrum of metastable, 18: 34817

SILVER ISOTOPES Ag-110
determination of internal, by radiochemical urine analysis, 18: 33519
half life, 18: 33943

SINGLE CRYSTALS
electron spin resonance spectra of oriented radicals in irradiated, 18: 33630

SKIN
decontamination of, 18: 33812
histology of, 18: 33224
iodine-131 uptake by, in animals and chickens, 18: 33251
percutaneous absorption routes in, 18: 33224
radiation effects on content of trace elements in, 18: 33285(T) (JPRS-25502)
radiation injuries of, in rats, 18: 33340
radiosensitivity of mouse, effects of anoxia on, 18: 33408

SKIN GRAFTING
immune reactions to, after temporary chimerism in irradiated rats, 18: 33387
radiation effects on acceptance of grafts, in rabbits, effects of post-irradiation time on, 18: 33386
radiation effects on graft acceptance in mice, effects of injected spleen and lymph node cells on, 18: 33388

SKIN LESIONS
radioinduced, in guinea pigs, effects of treatment with cigerol and lonol, 18: 33413

SODIUM
analysis for carbon and oxygen, 18: 33678(R) (ANL-6875)
analysis for carbon by isotope dilution mass spectrometry, 18: 33477
analysis for oxygen in test loop, 18: 35060(R) (ANL-6904)
burning of, dispersion of iodine and oxide particles from, 18: 35247(R) (NAA-SR-9700)
catalytic effects on radioinduced polymerization of solid 3,3-bis-chloromethyloxatane, 18: 33651
cavitation damage in liquid, research program on, 18: 34075 (NASA-CR-54071)
condensation of vapors of, irreversible, 18: 34323
content in mouse urine, radiosensitivity prediction by, 18: 33321
contents in meteorites, 18: 34398
corrosive effects of flowing, on chromium steel, chromium–molybdenum steel, and stainless steel, 18: 34073(R) (GEAP-4438)
determination in quartz, activation, 18: 33494
determination in silicon, activation, 18: 33502
effects on lubricating properties of fused fluoride coatings on chromium–nickel alloy, 18: 33695 (NASA-TN-D-2348)
effects on uptake of strontium-90 by barley and pea plants, 18: 33241
heat transfer of longitudinally flowing, between rod bunches, 18: 33744
measurement of level, wetting, and bubbles in liquid, apparatus for, 18: 33827 (EUR-1823.d)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
photon absorption cross sections for vapors of, at 1000 to 2400 Å, 18: 34443
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
properties as reactor working fluid, 18: 35198 (NAA-SR-8617(Vol.I))
purification, 18: 33678(R) (ANL-6875)
radiation effects on metabolism of, by fish, 18: 33272(R) (NIRS-2(p.31-42))
reactions with water, thermodynamics of, 18: 33528 (NP-14080)
reactivity effects of, as fast-ceramic-reactor coolant, 18: 35146(R) (GEAP-4601)
reactor criticality effects in SRE Core II, 18: 35149 (NAA-SR-9509)
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
solvent properties for rare gases, 18: 33678(R) (ANL-6875)
void coefficient measurements in ZPR-VI, 18: 35060(R) (ANL-6904)

SODIUM ALLOYS
K–Na, properties as reactor working fluid, 18: 35198 (NAA-SR-8617 (Vol.I))
K–Na, thermal properties of, effects on reactor transients, 18: 35146(R) (GEAP-4601)

SODIUM AZIDES
reactions with nitrogen-13 recoil atoms and thermal decomposition of, activities of yields in, 18: 33663

SODIUM CHLORATES
nuclear quadrupole coupling of chlorine-35 in, Stark effects in, 18: 34301

SODIUM CHLORIDES
beta scattering by, measurement of saturated backscattering from, 18: 35057
defect motion in, activation energies, 18: 34280(R) (NYO-2680-1)

electron bombardment at 100 to 600 ev, multiple emissions from, 18: 34450
H centers in, energy calculations, 18: 34280(R) (NYO-2680-1)
radioinduced color center in, Zeeman effect in, 18: 33644
radioinduced luminescence at 4 to 80°K, x, 18: 33648
radiosensitivity effect on barley seeds, 18: 33409
superconducting properties of cubic, empirical correlations for, 18: 34684 (UCRL-11368)
B_2O_3–NaCl–Na_2O, distribution of solutes between phases in, at 830°C, 18: 33534 (USNRDL-TR-760)
KCl–NaCl, interface phenomena with liquid lead, 18: 34050(R) (ORNL-3626(p.59-164))
LiCl–$MgCl_2$–NaCl, liquidus lines at 450 to 600°C, 18: 35060(R) (ANL-6904)
LiH–NaCl, phase diagram, 18: 35060(R) (ANL-6904)
$PuCl_3$–KCl–NaCl, phase studies and properties as reactor fuels, 18: 34050(R) (ORNL-3626(p.59-164))

SODIUM FLUORIDES
BeF_2–NaF–ThF_4, phase equilibria, 18: 33582
CaF_2–NaF, lubricating properties of fused coatings of, in air, hydrogen, liquid sodium, and vacuum, 18: 33695 (NASA-TN-D-2348)
KF–NaF–ThF_4, phase studies and properties as reactor blankets, 18: 34050(R) (ORNL-3626(p.59-164))
LiF–NaF–ZrF_4, corrosive effects on HyMu-80 and INOR-8 under hydrofluorination conditions, 18: 34034(R) (BMI-1672(Del.))

SODIUM FORMATES
use in simultaneous precipitation of fluoride and zirconium from dissolver solutions, 18: 33690(P)

SODIUM GRAPHITE REACTORS
review and survey of power, 18: 35161 (TID-8540(p.71-129))

SODIUM HYDROXIDES
use as scrubber material for ruthenium tetraoxide, 18: 34006(R) (ORNL-TM-889)

SODIUM IODIDES
performance in gamma spectrometry, 18: 34755 (IDO-16880-1)
response to electrons at 0.6 to 1 Mev, 18: 33902
scintillation processes in crystals of, 18: 33636
scintillation processes in thallium-activated, 18: 33636
tracer uses of iodine-131-labeled, for edema, 18: 33231(R) (NIRS-2 (p.49-56))

SODIUM IONS
distribution between phases in boron oxide–sodium chloride–sodium oxide system at 830°C, 18: 33534 (USNRDL-TR-760)

SODIUM IRIDIUM CHLORIDES
reactions with iridium-192 recoil ions, chemical behavior of labeled compound yields in, 18: 33662

SODIUM ISOTOPES Na-22
beta decay of, angular correlations in, 18: 34752(R) (CU(PNPL)-234)
diagnostic use of, calibration methods for, 18: 34274(R) (NIRS-2 (p.3-15))
energy level population in (α,d) reactions, 18: 34779 (UCRL-11341)
energy levels, 18: 34821
gamma spectra of, least-squares analysis of, 18: 33926
positron spectra, 18: 34783(T) (ORNL-tr-235)

SODIUM ISOTOPES Na-23
energy levels, 18: 34832
neutron reactions (n,α) with, angular distribution for, 18: 34876
neutron reactions (n,α) at 14 Mev, direct-interaction model for, 18: 34769 (NP-14085)
proton reactions (p,γ) with, cross sections, 18: 34752(R) (CU(PNPL)-234)
proton reactions (p,pγ) at 828 to 1100 kev, excitation and resonances in, 18: 34836

SODIUM ISOTOPES Na-24
determination of physico-chemical state in liquid media, by paper electrophoresis and radioactivity recording, 18: 33590
separation from potassium-42, electrophoretic, 18: 33590

SODIUM OXIDES
B_2O_3–NaCl–Na_2O, distribution of solutes between phases in, at 830°C, 18: 33534 (USNRDL-TR-760)

SODIUM PHOSPHATES
analytical use in determination of gadolinium, 18: 33481
radiolysis of, hydrogen yields in, 18: 33645

SODIUM REACTOR EXPERIMENT
operation, 18: 35247(R) (NAA-SR-9700)
sodium reactivity worth in Core II, 18: 35149 (NAA-SR-9509)

SODIUM SULFATES
effects on cerium reactions with oxalic acid in sulfuric acid media, 18: 33537

SODIUM TUNGSTATES
analytical use for titration of gadolinium in presence of bromocresol and methyl red mixed indicators, 18: 33510

SOILS
analysis of, oxygen-isotope, 18: 33787
plant uptake of fission products from, 18: 33239
radioisotope uptake by, 18: 35239
sorptive properties for chromium and cobalt from solutions, 18: 35235 (IDO-12036)
strontium content at Warsaw, 18: 33778
strontium exchange in Alaskan, factors affecting, 18: 33777
strontium precipitation from calcareous, calcium carbonate method for, 18: 33594
strontium-90 content in Western Slovakia, 18: 33776

SOLAR BATTERIES
development for space power systems, status of, 18: 34001
testing, 18: 33703

SOLAR FLARES
alpha flux from, 18: 34389
analysis of July 1961 event for hydrogen isotopes, 18: 34382 (NP-14141)
data on March 1964, 18: 34391
effects on cosmic-ray primary-secondary coupling coefficients, 18: 34472(T) (NASA-TT-F-126(p.273-9))
effects on manned space flight, computer analyses of, 18: 35048 (AMRL-TDR-64-11)

SOLAR RADIATION
effects on lunar surface, 18: 34392
effects on manned space flight, computer analyses of, 18: 35048 (AMRL-TDR-64-11)
geophysical effects of proton component of, 18: 34388
interactions with plasma, 18: 34984
interactions with geomagnetic fields, boundary region in, 18: 34675
simulation, 18: 33703

SOLDERS
radiation effects on, 18: 33839 (RTD-TDR-63-4287(Vol.II))

SOLENOIDS
design of 300-kgauss, for intermittent operation, 18: 33714
field energy removal from superconducting, methods for, 18: 34690

SOLIDS
defects in, research program on lattice and electronic, 18: 34280(R) (NYO-2680-1)
shock front position in, method for continuous measurement of, 18: 34357

SOLVENT EXTRACTION PROCESSES
development, 18: 34007(R) (ORNL-TM-890)

SOLVENTS
analysis of organic, for water traces using kryptonates, 18: 33450(R) (NYO-2757-4)

SOUND
propagation in helium-II, fourth sound, 18: 34725

SOVIET UNION
sulfur-34 content in sulfides from copper–nickel deposits in, 18: 33767

SPACE
bibliography on properties and phenomena in, 18: 34383(T) (NASA-TT-F-229)
environmental effects on materials, 18: 34235
hydromagnetic shocks in, collisionless, 18: 34393
massive condensation in, theory of, 18: 34394

SPACE FLIGHT
analysis of logistic vehicle for lunar, using nuclear-electric propulsion, 18: 35210
ion engines for, automatic control systems for, 18: 33698
nuclear rockets in, 18: 35214
propulsion requirements for unmanned scientific planetary missions, 18: 35197(R) (64SD700)
radiation hazards during, 18: 33354
radiation hazards in, computer analyses of, 18: 35048 (AMRL-TDR-64-11)
radiation protection measures for, 18: 33815
simulation of ion engine performance in, 18: 34261 (AEDC-TDR-64-127)

SPACE VEHICLES
analysis of lunar, using nuclear-electric propulsion, 18: 35210
control of, ion engine systems for, 18: 33699
design and development of thermionic- and turboelectric-powered, 18: 35197(R) (64SD700)
electric power system for manned orbital, 18: 33719
electric power systems for, electrostatic, 18: 33720
ion engines for, 18: 33704
materials testing for nuclear-powered, 18: 34247
performance of nuclear-electric, using SNAP-50, 18: 35211
power systems for, materials development for, 18: 34046(R) (NASA-CR-54041)
propulsion by thermonuclear fusion, feasibility of, 18: 34973 (ASD-TDR-63-696)

propulsion of, status of arc-jet, 18: 33705
propulsion system for manned, electrothermal arc-jet, 18: 33706
propulsion systems for, d-c–to–d-c converters for electric, 18: 34497(R) (NP-12888(Vol.5))
propulsion systems for, status of electric, 18: 33702
propulsion systems for, development status of nuclear, 18: 35216
radiation effects on telemetry electronics of, 18: 33838 (RTD-TDR-63-4287(Vol.I))
re-entry to Earths atmosphere, development of refractory metal coatings for use in, 18: 34209
refractory metals for thermal protection in, status of, 18: 34062
shielding of manned, computer analyses of, 18: 35048 (AMRL-TDR-64-11)
switchgear development for, 18: 33828(R) (NASA-CR-54059)
testing of, for nuclear test detection, 18: 33703
use of beryllium in, nonstructural and structural, 18: 34141
welding of alloys and metals for, electron beam, 18: 34092

SPARK DETECTORS
cascade particle detection in, efficiency for, 18: 33966
data extraction systems for, spatial resolution of, 18: 33924
development, 18: 33923
development, 18: 33965
review, 18: 33967
spark spatial accuracy in, 18: 33924

SPECTROMETERS
design of Digitron time-interval, 18: 34752(R) (CU(PNPL)-234)
development of liquid scintillation, for carbon-14 and tritium detection, 18: 34274(R) (NIRS-2(p.3-15))
pulse-height spectra of scintillation, analysis of, 18: 33925

SPECTROPHOTOMETRY
book: *Advances in Catalysis and Related Subjects*, 18: 33453

SPECTROSCOPY
source development for uranium isotope measurements by emission, 18: 33459 (CEA-R-2428)

SPERM
storage of Drosophila, mutagenic effects of, 18: 33273(R) (NIRS-2(p.42-8))

SPERMATOGENESIS
radiation effects on Drosophila X chromosome during, gamma, 18: 33378

SPHERES
gamma transmission through shielding, Monte Carlo calculations for, 18: 35052
neutron flux distributions in air- and boron trifluoride-filled, 18: 34731 (NASA-CR-54110)

SPINAL CORD
radiation effects on Nissl granules in rat, 18: 33349

SPLEEN
radiation effects on lipid, nucleic acid, and protein synthesis in rat, 18: 33382
radiosensitivity effects of transplants of mouse parental, 18: 33320
radium-228 biological half life in, 18: 34274(R) (NIRS-2(p.3-15))
removal of rat, therapeutic effects of post-irradiation, 18: 33415

SPORES
radiation effects on germination and growth of *B. subtilis*, 18: 33292
radiosensitivity of bacterial, 18: 33278 (STI/DOC/10/28(p.39-66))
radiosensitivity of desoxyribonucleic acid in *B. subtilis*, effects of 5-bromodeoxyuridine on, 18: 33402
radiosensitivity of bacterial, effects of freezing and postirradiation heating on gamma, 18: 33996

SPUTTERING
equipment for, design of high-vacuum, 18: 33875(P)

STABLE ISOTOPES
contents in meteorites, 18: 34400

STACK DISPOSAL
contamination of ground-level air by, 18: 33801 (HW-80204)

STAINLESS STEEL
cavitation by liquid sodium, 18: 34075 (NASA-CR-54071)
compatibility with beryllium–thorium–uranium alloy at 1500°F, 18: 34032(R) (BMI-1668(Del.))
compatibility with beryllium–thorium–uranium alloys and carbon–thorium–uranium systems, 18: 34034(R) (BMI-1672(Del.))
compatibility with uranium nitride at 1300°C, 18: 34035(R) (BMI-X-10053)
compatibility with beryllium–thorium–uranium alloy, 18: 34033(R) (BMI-1669(Del.))
corrosion by steam and water in reactor environment, 18: 34076 (TID-8540(p.213-330))
corrosion by titanium sponge at 900°C, 18: 33678(R) (ANL-6875)
corrosion by water under ATR conditions, 18: 34074 (IDO-24460)
corrosion of Type 316, by flowing sodium, 18: 34073(R) (GEAP-4438)
creep of type 304L in lithium, biaxial, 18: 34030 (APL-TDR-64-73)
decontamination of, comparison of solutions for, 18: 35127(R) (GEAP-3771-13)
elastic properties of pipes of, at high temperatures, 18: 34175
heat transfer across contacting surfaces of, 18: 33735 (MIT-2079-2)
radiation effects on mechanical properties of niobium-stabilized austenitic, neutron, 18: 34218 (ORNL-TM-881)
reactions with plutonium nitride, 18: 34032(R) (BMI-1668(Del.))
reactions with steam, reactor safety studies of, 18: 33678(R) (ANL-6875)
sorptive properties for young fission products from solutions, 18: 33448 (IDO-14644)
stress-rupture properties of niobium-stabilized austenitic, in-reactor, 18: 34218 (ORNL-TM-881)
thermal properties of 347, effects on reactor transients, 18: 35146(R) (GEAP-4601)
use of type 347, in gas-cooled reactors, 18: 34034(R) (BMI-1672(Del.))
welding of, characteristics of electron beam, 18: 34112

STAINLESS STEEL (AUSTENITIC)
corrosion by steam and water in reactor environment, 18: 34076 (TID-8540(p.213-330))

STAINLESS STEEL (FERRITIC)
corrosion by steam and water in reactor environment, 18: 34076 (TID-8540(p.213-330))

STANDARDS
for estimating recrystallization, inclusions, and stringers in uranium, 18: 34047 (NLCO-910)

STANFORD LINEAR ACCELERATOR
development, Jan. 1–Mar. 31, 1964, 18: 34372(R) (SLAC-30)

STARS
development of associations of, theory of, 18: 34394
element abundances in K-giant, 18: 34385
evolution of massive, carbon production in, 18: 34386
neutrino pair emission by excited nuclei in, 18: 34932
radio wave emission by, 18: 34395

STATISTICS
formalism for nuclear particle counting and pulse spectrometry, generating functions in, 18: 33964
of emulsion scanning, 18: 33892
uses for analysis of dead-time effects on counter efficiency, 18: 33899

STEAM
reactions with aluminum and its alloys, 18: 35060(R) (ANL-6904)
reactions with metals, reactor safety studies of, 18: 33678(R) (ANL-6875)
separation from water, development of centrifugal separators for, 18: 33693(R) (ACNP-64026)
steam–H_2O, pressure drop in forced boiling flow, 18: 33745
steam–water, burnout heat flux in annulus, 18: 33730 (AERE-R-4352)

STEEL
fatigue properties of A105 and A302, 18: 35154(R) (SWRI-1228-28)
mechanical properties of types 13C, 17C, 23A, 23C, 27A, 33A, and 37A, 18: 34089(T,R) (EURAEC-915)
properties for use as reactor pressure vessels, 18: 34097
properties of welded, 18: 34089(T,R) (EURAEC-915)
radiation effects on pressure-vessel, research program on fast-neutron, 18: 34219 (RCN-26)
separation of cerium from high-alloy, by precipitation using hydrofluoric acid, 18: 33504
welding of thick, 18: 34089(T,R) (EURAEC-915)

STEROIDS
photochemical rearrangement of 3,20-diethylenedioxy-11-oxo-C-nor-5α-pregnane, formation of aldehyde in uv, 18: 33634
3-oxo-4,5-oxido-, photochemical rearrangement of, 18: 33635

STEROIDS, 17-KETO-
excretion in irradiated cervical carcinoma, 18: 33287

STOCHASTIC METHODS
models for neutron multiplication in reactors, 18: 35070 (TID-7679 (p.29-59))

STORAGE BATTERIES
development for space power systems, status of, 18: 34001

STRANGE PARTICLES
production in elementary-particle interactions at high energies, 18: 34509 (NP-14086)

STRESS CORROSION
review of fuel-element-cladding, 18: 34076 (TID-8540(p.213-330))

STRONTIUM
content in Pacific skeletal aragonites, 18: 33259
content in soil at Warsaw, 18: 33778
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
effects on growth and nitrogen fixation in Nostoc, 18: 33237
exchange in Alaskan soil, factors affecting, 18: 33777
metabolism by rats, effects of diet on, 18: 33805(R) (NIRS-2(p.57-67))
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R)

(NIRS-2(p.3-15))
precipitation in calcareous soils by calcium carbonates, 18: 33594
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
separation from calcium by solvent extraction, effects of sodium concentration in organic feed on, 18: 34007(R) (ORNL-TM-890)
separation from water, method for, 18: 33484
solubility of, in bones, 18: 33240
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
uptake by fish gills, comparison with calcium, 18: 33805(R) (NIRS-2 (p.57-67))
STRONTIUM CARBONATES
radiation effects on structure of, fast neutron, 18: 34241
STRONTIUM CHLORIDES
radioinduced coloration in, spectra of, 18: 33643
STRONTIUM IONS
distribution between phases in boron oxide–sodium chloride–sodium oxide system at 830°C, 18: 33534 (USNRDL-TR-760)
STRONTIUM ISOTOPES
redistribution during metamorphism in Panamint Range, California, 18: 33793
STRONTIUM ISOTOPES Sr-84
deuteron elastic scattering at 13.6 Mev, angular distributions for, 18: 34942
STRONTIUM ISOTOPES Sr-85
distribution of tracer dose in man, whole-body counting of, 18: 33233(R) (NYO-910-9)
uptake by bone, parathyroid hormone removal of, 18: 33231(R) (NIRS-2(p.49-56))
use in radiochemistry and tracer techniques, optimum counting methods for, 18: 33655
STRONTIUM ISOTOPES Sr-86
deuteron elastic scattering at 13.6 Mev, angular distributions for, 18: 34942
STRONTIUM ISOTOPES Sr-87
deuteron elastic scattering at 13.6 Mev, angular distributions for, 18: 34942
STRONTIUM ISOTOPES Sr-88
deuteron elastic scattering at 13.6 Mev, angular distributions for, 18: 34942
STRONTIUM ISOTOPES Sr-89
beta decay of, internal bremsstrahlung from, 18: 34837
determination in fresh water basins, radiochemical, 18: 33769 (NP-14091)
metabolism by plankton, 18: 35238 (STI/DOC/10/28(p.9-20))
preparation of Decalso glass sources of, 18: 34007(R) (ORNL-TM-890)
use in radiochemistry and tracer techniques, optimum counting methods for, 18: 33655
STRONTIUM ISOTOPES Sr-90
content in bones of cattle, sheep, and swine, species and individual bone differences in, 18: 33240
content in fallout and soil in Western Slovakia, 18: 33776
content in people in France, 1961–1964, 18: 33429
content of, in fish in Irish Sea, 18: 33248
determination in fresh water basins, radiochemical, 18: 33769 (NP-14091)
determination in urine, 18: 33518
determination of physico-chemical state in liquid media by paper electrophoresis and radioactivity recording, 18: 33590
gamma spectra of, least-squares analysis of, 18: 33926
medical uses, 18: 33436
metabolism by plankton, 18: 35238 (STI/DOC/10/28(p.9-20))
metabolism of, in bones of rabbits, 18: 33261
pathological effects in dogs, delayed, 18: 33342
properties for use as heat source in direct conversion devices, 18: 34002
separation from Hanford wastes for use as heat sources, 18: 33983 (HW-SA-3080(Rev.))
separation from organic waste solutions by ion exchange, 18: 35240
uptake by above-ground plant parts of, from air, 18: 33235(T) (AEC-tr-6448)
uptake by barley and pea plants, effects of calcium, potassium, and sodium on, 18: 33241
uptake by Japanese vegetables from fallout, 18: 33805(R) (NIRS-2 (p.57-67))
uptake by plants from soil and irrigation water, 18: 33239
STRONTIUM OXIDES
effects on plutonium dioxide, 18: 34049(R) (NUMEC-P-106)
STRONTIUM SULFATES
reduction by hydrogen, 18: 33529 (ORNL-3334(Pt.II))
STRONTIUM TITANATES
electron energy bands in, 18: 33586
preparation by precipitation, 18: 34006(R) (ORNL-TM-889)
radiation effects on crystal structure and polarization of, fast-neutron 18: 34246
STRUCTURES
gamma dose rates in concrete, 18: 35055
STYRENE POLYMERS
radioinduced scintillation output from, alpha, 18: 33638
SUBMARINE REACTORS
development of, review of, 18: 35178
SUBMARINES
testing under high pressures, nuclear excavation of subterranean chamber for, 18: 33709 (SC-TM-64-636)
SUGAR BEETS
radiation effects on extracts of cellular structure of leaves of, by seed exposure, 18: 33314
SULFATES
separation from beryllium fluoride–lithium fluoride systems, 18: 34050(R) (ORNL-3626(p.59-164))
SULFIDES
sulfur-34 content in, from copper–nickel deposits in Soviet Union, 18: 33767
SULFONATES
mutagenic effects in *Vicia faba*, 18: 33303
SULFUR
contents in meteorites, 18: 34398
determination in beryllium, niobium, and zirconium and their oxides, luminescent method for, 18: 33513
determination in liquid oil products by x-ray absorption, instrument for, 18: 33472(T) (AEC-tr-6399(p.98-114))
determination simultaneously with zirconium in organic compounds, amperometric, 18: 33514
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
SULFUR DIOXIDES
preparation for determination of sulfur-32 ratio with sulfur-34 in ores and rocks, 18: 33501
spectra of, rotational, 18: 34292
SULFUR FLUORIDES
benzene–SF_6, recombination rates for gaseous, 18: 33555
NO–SF_6, recombination rates for gaseous, 18: 33555
SULFUR ISOTOPES
separation in calutrons, 18: 34005(R) (ORNL-TM-879)
separation of stable, in calutrons, 18: 34005(R) (ORNL-TM-879)
SULFUR ISOTOPES S-32
alpha reactions (α,d) at 45 to 50 Mev, highly populated levels in, 18: 34779 (UCRL-11341)
determination of ratio with sulfur-34 in ores and rocks, 18: 33501
deuteron reactions (d,p) with, cross sections, 18: 34752(R) (CU(PNPL)-234)
energy levels, 18: 34924
neutron reactions (n,α) with, 18: 34799
neutron reactions (n,d) at 14 Mev, 18: 34818
SULFUR ISOTOPES S-33
energy levels, 18: 34799
SULFUR ISOTOPES S-34
content in sulfides from copper–nickel deposits in Soviet Union, 18: 33767
determination of ratio with sulfur-32 in ores and rocks, 18: 33501
SULFUR ISOTOPES S-35
beta decay of, mean energies of, 18: 34785
determination of internal, by radiochemical urine analysis, 18: 33519
SULFUR SYSTEMS
paraffin-S, radiation effects on polarization of, 18: 33622
SULFURIC ACID
effects on ion exchange properties of titanium and zirconium salts, 18: 33535
SUN
activity of, geomagnetic effects of sunspot, 18: 34387
SUPERCONDUCTIVITY
magnetic field effects on, in thin films, 18: 34682(R) (NBS-8407)
self-energy of Bogoliubov quasi-particle, 18: 34687
theory, 18: 34694
theory of, electron-phonon interaction in, 18: 34722
theory of, integrodifferential equations of nonlocal, 18: 34692
wires for, properties of materials for, 18: 34200
SUPERCONDUCTORS
analysis of a-c loss mechanisms in hard and soft, 18: 34683(R) (NP-14136)
critical fields in niobium and niobium-oxygen solutions, 18: 34704
crystal structure studies in transition metal alloys, 18: 34283 (UCRL-

11390)
current-carrying capacity of, measurement of temperature dependence of, 18: 34681 (BSD-TDR-64-87)
development and properties of refractory alloys, intermetallic compounds, and metals for use as, 18: 34179
development for power generation, review of, 18: 34499
electric current distribution in, carrying quantized fluxoids, 18: 34688
electrodynamics of, effects of collective excitations on, 18: 34720
energy gap in thallium, ultrasonic determination of, 18: 34701
energy gap of, magnetic field strength dependence of, 18: 34721
infrared radiation absorption in, collective excitations in, 18: 34720
magnetic field penetration depth in, 18: 34721
magnetic flux jumps in hard, 18: 34724
magnetic flux quantization in hollow cylinders in magnetic field, 18: 34709
magnetic fluxoid conservation by thin film ring, 18: 34698
microwave amplification using films of, 18: 34714
microwave surface impedance of second kind, 18: 34705
performance in microwave mixers, 18: 33824(R) (AD-428788)
phase transitions in, mechanisms of, 18: 34719
properties of evaporated and sputtered films of niobium and tantalum and their compounds, 18: 34157
properties of indium alloys and compounds, 18: 34707
properties of titanium alloy, 18: 34700
properties of transition metal carbides as, 18: 34684 (UCRL-11368)
radiofrequency effects in thin, 18: 34710
theory of finite, infinite volume limit in, 18: 34703
thermal resistance at boundaries between sapphire and indium at 1.1 and 2.1°K, 18: 34699
tunneling in, microwave observation of quantum interference in, 18: 34696
uses of, a-c equipment, 18: 34715

SUPERFLUIDITY
self-energy of Bogoliubov quasi-particle, 18: 34687
theory of, in fermion systems, 18: 34864

SUPERHEATERS (NUCLEAR)
experiments on BORAX-V PSH-1, 18: 35060(R) (ANL-6904)
fuel element cladding behavior in, 18: 34076 (TID-8540(p.213-330))

SURFACE PROPERTIES
book: *Advances in Catalysis and Related Subjects*, 18: 33453

SURFACE WATERS
analysis for strontium-89 and -90, radiochemical, 18: 33769 (NP-14091)
effects of radioactive wastes on biological conditions in rivers, 18: 35238 (STI/DOC/10/28(p.9-20))
plant uptake of fission products from, 18: 33239

SURFACES
heat transfer across contacting, analysis of resistance of, 18: 33735 (MIT-2079-2)

SURGERY
strontium-90 needle for nervous system, 18: 33436

SWEDEN
radiation dose to population of, diagnostic, 18: 33419

SWIMMING POOL REACTORS
control system of SILOE, 18: 35227
design of Hitachi, 18: 35224
experimental facilities, irradiation enclosure design, 18: 35230(P)
fuel plate assembly with consumable poison, 18: 35231(P)
research and training at IRR-1, 18: 35219 (IA-894)
research program at IRR-1, 18: 35218 (IA-892)
surface water activity control in, using hot water layer, 18: 35226

SWINE
strontium-90 content in bones of, 18: 33240

SWITCHES
accuracy of strain-gage, 18: 35060(R) (ANL-6904)
design for operation under weightlessness, 18: 35259(P)
development and testing of, for space uses, 18: 33828(R) (NASA-CR-54059)
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))

SWITZERLAND
atomic energy developments in, 18: 35082

SYENITES
thorium content in Kola peninsula, geochemistry of, 18: 33797

SYNCHROCYCLOTRONS
magnet pole profiles for, analytic determination of, 18: 34376
shielding testing at Dubna proton, 18: 34374

SYSTEMS FOR NUCLEAR AUXILIARY POWER
development of, bibliography on, 18: 35204 (TID-3561(Rev.4))
fuel for SNAP 10A/2, fission product release from irradiated, 18: 34045 (NAA-SR-9673)
materials development for, 18: 34046(R) (NASA-CR-54041)
radiation effects on telemetry electronics of, 18: 33838 (RTD-TDR-63-4287(Vol.I))
reactivity transients in, kinetics of uncontrolled, 18: 35201 (NAA-SR-9368)

SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-2)
design criteria for, dynamic analysis of, 18: 35199 (NAA-SR-9054)
development status, 18: 34001

SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-8)
development status, 18: 34001

SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-9)
development status, 18: 34001

SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-10)
ablation and stability of, during re-entry, 18: 35212
development status, 18: 34001
structural analyses for 10A, static, vibration, and acoustic, 18: 35202 (NAA-SR-9655)
thermal testing 10A prototype (PSM-3), 18: 35200 (NAA-SR-9280)

SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-11)
development status, 18: 34001

SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-13)
development status, 18: 34001

SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-50)
development status, 18: 34001
performance of nuclear-electric space vehicles using, 18: 35211

SZILARD-CHALMERS REACTIONS
energy transfer in, review on theory of, 18: 33660
in solid xenon tetrafluoride, 18: 33666

T

TANTALUM
analysis for carbon, hydrogen, iron, nitrogen, and oxygen, review of methods for, 18: 33516
analysis for hydrogen, nitrogen, and oxygen, vacuum fusion, 18: 33491
analysis for impurities, review of methods for, 18: 33515
bibliography on analytical chemistry of, 18: 33482
bibliography on preparation, fabrication, and uses of, 18: 34151
compatibility with beryllium–thorium–uranium alloy at 1500°F, 18: 34032(R) (BMI-1668(Del.))
compatibility with beryllium–thorium–uranium alloy, 18: 34034(R) (BMI-1672(Del.))
conference on refractory metals, Oslo, Norway, June 23 to 26, 1963, 18: 34068
corrosion resistance of, effects of alloying and coating on, 18: 34084
crystallographic defects and structure of bulk and foil, 18: 34122(R) (GA-4900)
determination in silicon, activation, 18: 33502
determination of traces of, in niobium, x-ray spectrographic, 18: 33458 (BM-RI-6483)
determination of, tracer techniques for, 18: 33483
electron reactions at 10 and 20 Mev, bremsstrahlung from, 18: 34459
electron scattering by, energy loss mechanisms in relativistic, 18: 34258(R) (AD-417250)
electron states in superconducting, 18: 34708
electronic structure, physical properties, and alloying properties, 18: 34202
fabrication and properties for use as superconductors, 18: 34179
fabrication of powdered, method for, 18: 34117(P)
fabrication of, mechanical tests to evaluate, 18: 34101
fabrication of, review of primary working operations for, 18: 34104
fabrication, properties, and uses of, review on, 18: 34178
mechanical properties of, effects of trace elements on, 18: 34206
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
oxidation by air and gas mixtures, kinetics of, 18: 34083
physical properties of, effects of alloying additions and chemical reactions on, 18: 34205
plastic flow of single crystals of, effects of prestrains on, 18: 34122(R) (GA-4900)
polarization in aqueous sulfate solutions, electrochemistry of passivating oxide film formed in, 18: 34063
properties for use at high temperatures, 18: 34201
properties of, review on, 18: 34180
reactions with plutonium nitride, 18: 34032(R) (BMI-1668(Del.))
separation from niobium by solvent extraction using hydrofluoric acid–TBP, 18: 33688
solubility of nitrogen in, at 350 to 2300°C, 18: 33595
superconducting properties of evaporated and sputtered films of, 18: 34157
tensile properties of, effects of interaction of interstitial solute and sub-

structure on, 18: 34204
tensile properties of wrought, effects of oxygen on, 18: 34196
tensile properties of, effects of interstitial and substitutional solutes on, 18: 34203
tensile properties of, method of testing, 18: 34210
thermal expansion to 2000°C, 18: 34190
thermophysical properties, 18: 34207
welding of, embrittlement in, 18: 34108
TANTALUM ALLOYS
conference on refractory metals, Oslo, Norway, June 23 to 26, 1963, 18: 34068
development for high-temperature applications, review, 18: 34069
fabrication and properties for use as superconductors, 18: 34179
fabrication of, mechanical tests to evaluate, 18: 34101
properties of, review on, 18: 34180
sheet bending of, methods and problems of, 18: 34107
welding of, embrittlement in, 18: 34108
Hf–Ta, corrosion by water under ATR conditions, 18: 34074 (IDO-24460)
Nb–Ta, phase studies based on thermochemical data, 18: 33603
Nb–Ta–W, welding of SCb-291, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Nb–Ta–W–Zr, coating of FS-85, with palladium–platinum alloy and platinum, 18: 34029(R) (AD-601740)
Nb–Ta–W–Zr, welding of FS-85, electron-beam and tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Ta–W, fabrication and properties of, effects of carbon, hafnium, molybdenum, nitrogen, rhenium, and zirconium additions on, 18: 34059(R) (WANL-PR(Q)-003)
Ta–W, welding of, electron-beam and tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
TANTALUM CARBIDES
grinding, 18: 34095
superconducting properties of evaporated and sputtered films of, 18: 34157
NbC–TaC, superconducting properties of solid solutions of, 18: 34684 (UCRL-11368)
TANTALUM ISOTOPES
proton reactions at 660 Mev, terbium production in, 18: 34766 (JINR-P-1687)
TANTALUM ISOTOPES Ta-181
energy levels of, measurement of mean life of radioactive-decay-produced isomeric, 18: 34770 (NP-14115)
neutron inelastic scattering by, analysis of, 18: 34910
TANTALUM ISOTOPES Ta-182
analytical uses, 18: 33483
uptake by fish, 18: 33805(R) (NIRS-2(p.57-67))
TANTALUM NITRIDES
superconducting properties of evaporated and sputtered films of, 18: 34157
TANTALUM OXIDES
electrochemistry of passivating films of, formed on metal by polarization, 18: 34063
Al_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
CeO_2–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
Dy_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
Ga_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
Gd_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
In_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
La_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
Nd_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
Sc_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
Sm_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
Tl_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
Y_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
TECHNETIUM
separation from nitric acid concentrate by solvent extraction, 18: 34006(R) (ORNL-TM-889)
TECHNETIUM ALLOYS
Tc–Zn, phase studies and thermodynamic properties, 18: 33678(R) (ANL-6875)
TECHNETIUM CARBONYLS
spectra of, infrared, 18: 33551
TECHNICAL REPORTS
cataloging of, number series used by Division of Technical Information in, 18: 35251 (TID-85(3rd Rev.))
TEETH
mineral content of, in normal and rachitic rats, effects of vitamin D on, 18: 33277 (STI/DOC/10/28(p.21-38))
TEKTITES
analysis of, oxygen-isotope, 18: 33787
TELEMETERING SYSTEMS
radiation effects on telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation effects on telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
review of in-pile, 18: 35089 (TID-8540(p.177-211))
TELLURIC ACID
radiolysis of aqueous solutions of, chemical state of iodine-131 formed in neutron, 18: 33661
TELLURIUM
determination in biological materials, activation, 18: 33464 (NASA-CR-52997)
determination in silicon, activation, 18: 33502
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
spectra of, x-ray L-absorption and -emission, 18: 34412
x-ray L-emission spectrum, 18: 34410
TELLURIUM ISOTOPES Te-121
decay, 18: 34882
TELLURIUM ISOTOPES Te-131
buildup in research reactors, 18: 35228
TELLURIUM ISOTOPES Te-132
buildup in research reactors, 18: 35228
TELLURIUM ISOTOPES Te-133
buildup in research reactors, 18: 35228
TELLURIUM ISOTOPES Te-134
buildup in research reactors, 18: 35228
nuclear structure of, alpha cluster reduced widths for, 18: 34891
TELLURIUM ISOTOPES Te-135
buildup in research reactors, 18: 35228
TELLURIUM OXIDES
radiolysis of aqueous solutions of, chemical state of iodine-131 formed in neutron, 18: 33661
TELLURIUM SYSTEMS
Ge–Te, specific heat and bulk superconductivity of, 18: 34711
TEMPERATURE
distribution in radiation-cooled solid cylinder, 18: 33740 (SC-DC-64-891)
effects on Artemia eggs, 18: 33271(R) (NIRS-2(p.26-31))
effects on atmospheric cosmic-ray measurements, 18: 34469(T) (NASA-TT-F-126(p.224-9))
effects on irradiated strawberries in storage, 18: 33993
effects on *Saccharomyces cerevisiae* strains of yeasts, 18: 33393
measurement in reactors, quartz crystal-oscillator circuit for, 18: 33872(P)
radiosensitivity effects of freezing, on bacteria, 18: 33326
radiosensitivity effects on bacterial spores, 18: 33996
TERBIUM
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
TERBIUM COMPLEXES
with 2,4-pentanedione, quenching and temperature dependence of fluorescence, 18: 33556
TERBIUM ISOTOPES
alpha spectra, 18: 34766 (JINR-P-1687)
TERBIUM ISOTOPES Tb-160
beta decay of, K-forbidden, 18: 34844
TERPHENYL
fluorescence decay time in deuterated and natural, device for measuring, 18: 33637
neutron diffusion in, 18: 34734
pyrolysis and radiolysis of hydrogenated, 18: 33617 (AECL-1915)
pyrolysis and radiolysis of, evaluation of studies of, 18: 33619 (MITNE-48)
viscosity at high pressures and temperatures, 18: 33858
biphenyl–terphenyl, radiolysis and pyrolysis, 18: 33617 (AECL-1915)
TESTOSTERONE
effects on hemorrhagic diathesis in rats fed irradiated beef, 18: 33992
therapeutic effects against radiation effects on blood picture and survival of mice, 18: 33416
TETRACYCLINE
development of tolerance test using, for diagnosis of bone diseases, 18: 33233(R) (NYO-910-9)
THALLIUM
density of liquid, 18: 34131 (TID-20849)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
superconducting energy gap in, ultrasonic determination of, 18: 34701
THALLIUM ALLOYS
Hg–Tl, compound formation in, 18: 34131 (TID-20849)
Pb–Tl, superconductivity of, surface effects on, 18: 34683(R) (NP-14136)
THALLIUM FLUORIDES
hyperfine structure, Stark effects and Zeeman effect in, 18: 34936
THALLIUM ISOTOPES Tl-204

preparation of Decalso glass sources of, 18: 34007(R) (ORNL-TM-890)
properties for use as heat source in direct conversion devices, 18: 34002
THALLIUM ISOTOPES Tl-205
nuclear magnetic moments in thallium fluoride, 18: 34936
THALLIUM OXIDES
Tl_2O_3–Nb_2O_5, properties and structure of compounds formed in, 18: 34199
Tl_2O_3–Ta_2O_5, properties and structure of compounds formed in, 18: 34199
THERMAL DIFFUSION
column concentration gradients, mathematical study of, 18: 34005(R) (ORNL-TM-879)
separation of isotopes by, 18: 35246(R) (MLM-1196)
THERMAL INSULATION
design for concrete vessel of gas-cooled reactors, 18: 35104(P)
radiation effects on, at low temperatures, 18: 34247
THERMAL RADIATION
attenuation by atmosphere, 18: 34256
THERMAL REACTORS
criticality studies of, with plutonium recycling, 18: 35168
THERMAL STRESSES
in radiation-cooled solid cylinder, 18: 33740 (SC-DC-64-891)
THERMIONIC CELLS
design and development for space vehicle electric power systems, 18: 35197(R) (64SD700)
design with electron-emissive filaments, 18: 34504(P)
development for nuclear space propulsion systems, 18: 35216
development for space power systems, status of, 18: 34001
development of d-c–to–d-c converters for nuclear-, 18: 34497(R) (NP-12888(Vol.5))
development of, review of, 18: 34499
THERMOCOUPLES
chemical compatibility of rhenium/tungsten, with plutonia–urania mixtures, 18: 35146(R) (GEAP-4601)
drift of platinum–rhodium- and tungsten–rhenium-base, at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
THERMODYNAMICS
distribution functions of equilibrium systems of charged particles in, 18: 34415
theory for classical monatomic fluids, radial distribution function for, 18: 34344
THERMOELECTRIC CELLS
design of portable, for 5 to 100 w outputs, 18: 34503
development, 18: 33678(R) (ANL-6875)
development for space power systems, status for, 18: 34001
development of, review of, 18: 34499
electrode fabrication and performance for, metal matrix-refractory additive, 18: 34505(P)
THERMOLUMINESCENCE
design of dosimeter using, 18: 33981(P)
THERMOMETERS
design and testing of ultrasonic, 18: 33832(R) (NYO-10560)
THERMOMETRY
instrumentation for micro-thermogravimetric analysis, 18: 35146(R) (GEAP-4601)
THERMONUCLEAR REACTIONS
use in space propulsion, 18: 34973 (ASD-TDR-63-696)
THERMONUCLEAR REACTORS
development for power generation, review of, 18: 34499
developments review, 18: 35017
THICKNESS GAGES
radiometric, applications in building-materials industry, 18: 33852(T) (AEC-tr-6399(p.196-201))
THIOSULFURIC ACID, AMINOETHYL-
N-methyl-, protective effects against x radiation in mice, 18: 33418(P)
THORIUM
abundance in solar system, 18: 34401
analysis of irradiated, for uranium isotopes, 18: 33462 (DP-883)
content in mesozoic nepheline syenites of Kola peninsula, geochemistry of, 18: 33797
crystal structure and phase studies, effects of rare earth additions on, 18: 34053(R) (TID-20862)
determination in urine, 18: 33518
electric conductivity at 300°K, reduced Ziman, 18: 34164
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
properties as reactor fuel, 18: 34130 (TID-8540(p.331-410))
separation from rare earths, zirconium, and other elements by paper chromatography, 18: 33505
structure of, lattice spacing measurements at 25 to 460°C, 18: 34161
THORIUM ALLOYS
Be–Th–U, compatibility with Inconel, niobium, stainless steel, and tantalum at 1500°F, 18: 34032(R) (BMI-1668(Del.))
Be–Th–U, compatibility with metals and alloys at 1000 and 1500°F, 18: 34033(R) (BMI-1669(Del.))
Be–Th–U, compatibility with metals and alloys at 1500 and 2000°F, 18: 34034(R) (BMI-1672(Del.))
Ce–Th, lattice spacing measurements at 25 to 460°C, 18: 34161
THORIUM FLUORIDES
BeF_2–NaF–ThF_4, phase equilibria, 18: 33582
KF–NaF–ThF_4, phase studies and properties as reactor blankets, 18: 34050(R) (ORNL-3626(p.59-164))
THORIUM(IV) FLUORIDES
BeF_2–LiF–ThF_4–UF_4–ZrF_4, radiation effects on, 18: 34050(R) (ORNL-3626(p.59-164))
THORIUM IONS
binding to bovine serum albumin-stabilized emulsions, 18: 33575
THORIUM ISOTOPES Th-227
separation from actinium-227 by ion exchange, 18: 35246(R) (MLM-1196)
THORIUM ISOTOPES Th-228
gamma spectra of, least-squares analysis of, 18: 33926
nucleon vibrational-rotational interactions in, 18: 34950
properties for use as heat source in direct conversion devices, 18: 34002
THORIUM ISOTOPES Th-230
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950
THORIUM ISOTOPES Th-232
deposition of, from thorotrast, in patients, 18: 33269
determination in man of, by whole-body counting, 18: 33269
energy levels of, vibration-rotation interactions in, 18: 34846
fission of, cluster-model, 18: 34872
neutron inelastic scattering by, analysis of, 18: 34910
nucleon vibrational-rotational interactions in, 18: 34950
THORIUM(IV) OXIDES
determination of radiation dose from thorotrast deposits in patients, 18: 33269
neutron resonance integrals for, temperature dependence of, 18: 34741
preparation of hydrothermally stable sols of, 18: 33609(P)
preparation of sols of, 18: 33608(P)
radiation effects of kidney deposits, 18: 33426
radon-220 content in human breath from, 18: 33425
BeO–ThO_2–UO_2–Y_2O_3, fuel retention at high temperatures, 18: 34040(R) (GEMP-36A)
BeO–ThO_2–UO_2–Y_2O_3, mechanical and thermal properties of, 18: 34040(R) (GEMP-36A)
ThO_2–UO_2–Y_2O_3, phase studies, 18: 34040(R) (GEMP-36A)
THORIUM PHOSPHIDES
fabrication and properties, 18: 35060(R) (ANL-6904)
THORIUM SULFIDES
thermoelectric properties, 18: 33678(R) (ANL-6875)
THORIUM SYSTEMS
B–Th–U, compression tests of $(Th,U)B_4$, 18: 34034(R) (BMI-1672(Del.))
C–Th–U, compatibility with Inconel and stainless steel, 18: 34034(R) (BMI-1672(Del.))
THRESHOLD DETECTORS
development for auroral phenomena, 18: 33935
response, 18: 35218 (IA-892)
THULIUM
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
THULIUM ISOTOPES Tm-169
energy level of, lifetime of 138.9-kev, 18: 34795
energy levels of, properties of ground-state rotational band, 18: 34794
THULIUM ISOTOPES Tm-170
determination in feces of, after inhalation, 18: 33266
properties for use as heat source in direct conversion devices, 18: 34002
THULIUM ISOTOPES Tm-171
energy levels of, lifetimes of rotational, 18: 34796
THULIUM ISOTOPES Tm-174
beta decay of, ytterbium-174 isomers from, 18: 34896
THYMIDINE
radiation effects on metabolism of, in liver of partial-hepatectomized rats, 18: 33294
radiolysis, 18: 33658
uptake of tritiated, by human chromosomes, 18: 33253
THYMINE
radiation effects on dimer excision in *E. coli* of, uv, 18: 33298
THYROID DISEASES
diagnosis using iodine-131-labeled triiodothyronine, 18: 33437
etiology of goiter, 18: 33278 (STI/DOC/10/28(p.39-66))
radiotherapy of, dose to medical personnel from, 18: 33421
THYROID GLAND

function tests on, iodine-131-labeled triiodothyronine in, 18: 33437
physiology of, effects of pituitary hormones on, 18: 33278 (STI/DOC/10/28(p.39-66))
protein synthesis in rat, relation of iodine metabolism to, 18: 33212(R) (NYO-2570-1)
THYROID HORMONES
metabolism of, tracer studies in rats and pituitary homogenates, 18: 33278 (STI/DOC/10/28(p.39-66))
THYRONINE, TRIIODO-
uptake of iodine-131-labeled, by resin, 18: 33437
TIN
activation by thermal neutrons, self-shielding effects in, 18: 33488
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
beta scattering by, measurement of saturated backscattering from, 18: 35057
effects in scintillator plastics on gamma detection efficiency, 18: 33939
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
gamma coherent scattering at small angles, 18: 35053
ionization by electron and positron impact, 18: 34431
magnetic flux quantization in superconducting cylinder of, rate of, 18: 34709
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
radioinduced reactions with butyl bromide, product yields, 18: 34032(R) (BMI-1668(Del.))
radioinduced reactions with butyl bromide, effects of variables on products of, 18: 34033(R) (BMI-1669(Del.))
radioinduced reactions with butyl bromide, dose effects on product yields in, 18: 34034(R) (BMI-1672(Del.))
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
spectra of, x-ray L-absorption and -emission, 18: 34412
superconductivity of, effects of impurities on, 18: 34693
superconductivity of, microwave study of tunneling in, 18: 34696
x-ray L-emission spectrum, 18: 34410
TIN ALLOYS
superconductivity of binary and isoelectronic, 18: 34693
Al–Sn, deposition on D-14 niobium alloy, 18: 34052 (RTD-TDR-63-4063)
Li–Sn, thermodynamic properties, 18: 33678(R) (ANL-6875)
Nb–Sn, crystallography and phase equilibrium in, 18: 34165
Nb–Sn, properties for use as superconductive wires, 18: 34200
Nb–Sn, radiation effects of neutrons on superconductivity of, 18: 34683(R) (NP-14136)
Nb–Sn, superconducting magnets of, 18: 34715
Pb–Sn, beta scattering from, 18: 35057
Sb–In–Sn, superconductivity in, 18: 34707
Sn–V–Zr, corrosion by steam at 350, 400, and 480°C, hydrogen sorption during, 18: 34060(T,R) (EURAEC-1062)
Sn–V–Zr, fabrication and mechanical properties, effects of heat treatments on, 18: 34060(T,R) (EURAEC-1062)
Sn–Zn, beta scattering from, 18: 35057
TIN COUPLES
Al/Sn, superconductivity, 18: 34723
TIN ISOTOPES
separation in calutrons, 18: 34007(R) (ORNL-TM-890)
TIN ISOTOPES Sn-116
deuteron elastic scattering at 13.6 Mev, angular distributions for, 18: 34942
deuteron inelastic scattering at 13.6 Mev, excitation in, 18: 34941
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
TIN ISOTOPES Sn-117
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
TIN ISOTOPES Sn-118
deuteron elastic scattering at 13.6 Mev, angular distributions for, 18: 34942
deuteron inelastic scattering at 13.6 Mev, excitation in, 18: 34941
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
TIN ISOTOPES Sn-119
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
TIN ISOTOPES Sn-120
deuteron elastic scattering at 13.6 Mev, angular distributions for, 18: 34942
deuteron inelastic scattering at 13.6 Mev, excitation in, 18: 34941
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
TIN ISOTOPES Sn-122
deuteron elastic scattering at 13.6 Mev, angular distributions for, 18: 34942
deuteron inelastic scattering at 13.6 Mev, excitation in, 18: 34941
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
TIN ISOTOPES Sn-124
deuteron elastic scattering at 13.6 Mev, angular distributions for, 18: 34942
deuteron inelastic scattering at 13.6 Mev, excitation in, 18: 34941
neutron radiative capture cross sections at 30 kev, 18: 34274(R) (NIRS-2(p.3-15))
TISSUE CULTURES
radiation effects on kidney cells in, lethal, 18: 33278 (STI/DOC/10/28(p.39-66))
radiation effects on Forssman-antigen synthesis in hamster and mouse, x, 18: 33317
radiation effects on sister chromatid exchange in chromosomes of hamster cells in, 18: 33329
radioinduced polyploidy in Chinese hamster cell, x, 18: 33383
TISSUES
analysis for alpha sources, 18: 33819
grafting tracheal, radioinduced esophageal lesion repair by, 18: 33219
polonium-210 content of human, 18: 33819
radiation doses in, determination of, 18: 33428
radiation effects on, pathologic study of, 18: 33296
radiation effects on liberation of polydesoxyribonucleotides from, 18: 33308
radiation sickness effects on lysine metabolism in rat calcified, 18: 33346
radiosensitivity of animal, effects of oxygen concentration on, 18: 33404
TITANIUM
analysis for hydrogen equipment for, 18: 33511
cavitation by liquid sodium, 18: 34075 (NASA-CR-54071)
contents in meteorites, 18: 34398
corrosive effects of sponge-type, on Inconel, stainless steel, and Hastelloys, 18: 33678(R) (ANL-6875)
deposition on D-14 niobium alloy, 18: 34052 (RTD-TDR-63-4063)
fabrication of powdered, method for, 18: 34117(P)
gamma attenuation at 0.1 to 10 Mev, coefficients for, 18: 35058
grain growth in high-temperature phase, 18: 34139
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
properties of, review on, 18: 34180
separation from cerium-TTA solutions by solvent extraction using cupferron–chloroform, 18: 33540
TITANIUM ALLOYS
analysis for hydrogen, equipment for, 18: 33511
properties of, review on, 18: 34180
Co–Ti, magnetic moments and superconductivity of, 18: 34700
Mn–Ti, magnetic moments and superconductivity of, 18: 34700
Mn–Ti–Zr, magnetic moments and superconductivity of, 18: 34700
Mo–Nb–Ti, oxidation at 1000 to 1200°C, 18: 34079
Mo–Ti–Zr, coating of TZM, with palladium–platinum alloy and platinum, 18: 34029(R) (AD-601740)
Mo–Ti–Zr, properties of TZM foils at high temperatures, effects of coatings on mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)
Mo–Ti–Zr, tensile properties of TZM at room temperature and 650°C, 18: 35060(R) (ANL-6904)
Nb–Ti, oxidation at 1000 to 1200°C, 18: 34079
Nb–Ti, superconductivity of, surface effects on, 18: 34683(R) (NP-14136)
Nb–Ti–Zr, properties of D-36 foils at high temperatures, effects of coatings on mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4058)
Ti–V, development for use as cladding on fast reactor fuels, 18: 35060(R) (ANL-6904)
Ti–Zr, creep activation in, limiting values for, 18: 34152
Ti–Zr, magnetic moments and superconductivity of, 18: 34700
TITANIUM CARBIDES
grinding, 18: 34095
TITANIUM IONS
separation from zirconium by ion exchange on pyrocatechol-*O*,*O*-diacetic acid, 18: 33508
TITANIUM ISOTOPES Ti-46
energy levels of, half life of second excited, 18: 34752(R) (CU(PNPL)-234)
TITANIUM OXIDES
crystal transformation, mechanism of anatase-rutile, 18: 35253 (UCRL-11001)
effects on density of sintered uranium dioxide, 18: 35060(R) (ANL-6904)
effects on properties and sinterability of zirconium oxide, 18: 34155

radiation effects on crystal structure of, fast neutron, 18: 34241
TITANIUM PHOSPHATES
ion exchange properties of, effects of acids and hydrolysis on, 18: 33535
TITANIUM SYSTEMS
Cr–Si–Ti, coating processes for cementation on refractory metals, 18: 34091
TOLUENE
radiolysis, 18: 35247(R) (NAA-SR-9700)
TOLUENE, VINYL- POLYMERS
radioinduced scintillation output from, alpha and gamma, 18: 33638
TOXINS
effects on circulation of transfused blood platelets in rats, 18: 33215(R) (TID-20824)
radiation effects on mouse sensitivity to bacterial endo-, 18: 33370
radiation effects on biological activity of snake venom, of *Ancistrodon piscivorus*, 18: 33385
TRACER TECHNIQUES
book: *Nuclear and Radiochemistry*. Second Ed., 18: 33455
development of krypton-85 as universal tracer, 18: 33450(R) (NYO-2757-4)
radioisotopes and counting methods for, method for choosing optimum, 18: 33655
TRACER TECHNIQUES (BOTANY)
tritium-labeled-chromosomes, effects of x radiation on, 18: 33318
TRACER TECHNIQUES (CHEMISTRY)
analysis of, in oxidation and solvolytic reaction mechanisms, 18: 33985
development for analytical chemistry, 18: 33483
TRACER TECHNIQUES (ENGINEERING)
measurement of fluid flow rates by, method for, 18: 33750
TRACER TECHNIQUES (GEOLOGY)
oxygen-16/18 analysis of mollusk fossil shells, 18: 33784
TRACER TECHNIQUES (MEDICINE)
applications in liver function tests, 18: 33214 (STI/DOC/10-28(p.105-11))
applications in studies of iron metabolism, 18: 33214 (STI/DOC/10-28(p.105-11))
applications in studies of erythrocyte life span, 18: 33214 (STI/DOC/10-28(p.105-11))
development of, for visualization of isotope distribution on colored scintigrams, 18: 33968
development of, using whole-body scanning of radioisotope retention, 18: 33232(R) (NYO-910-3)
double trace method for measuring intestinal iron absorption, 18: 33440
for brain blood flow measurements, 18: 33441
for representation of pancreas, 18: 33442
human albumin and sodium iodide for edema, 18: 33231(R) (NIRS-2 (p.49-56))
use for detection of metastatic cancers, 18: 33233(R) (NYO-910-9)
TRACER TECHNIQUES (METEOROLOGY)
atmospheric movements, use of long-lived nuclear products for, 18: 34255
TRADESCANTIA
radiation effects on membrane formation in, 18: 33372
TRANSDUCERS
design, 18: 35040
development and operation of rhenium-gas-bulb-pressure, 18: 35127(R) (GEAP-3771-13)
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
TRANSFORMERS
design and performance of liquid metal-cooled, 18: 35197(R) (64SD700)
radiation effects on performance of, in telemetry electronics, 18: 33838 (RTD-TDR-63-4287(Vol.I))
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
TRANSISTORS
radiation and environmental effects in space, 18: 34235
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
use in high-speed analog pulse dividers, 18: 33929
use in time-to-pulse-height converters, 18: 33930
use of field-effect, in semiconductor preamplifier, 18: 33927
use of planar, in logarithmic amplifiers, 18: 33836 (RT/EL(64)-5)
use of tunnel diode, in recycling pulse generators, 18: 33857
use of tunnel-diode, in time-to-pulse-height systems, 18: 33931
TRANSITION METALS
electron states in superconducting, 18: 34708
TREES
radiation effects on secondary xylem development in *Q. alba* and *L. styraciflua*, 18: 33282 (TID-20876)
radiation effects on carbon dioxide exchange by *Pinus rigida*, 18: 33315
radiosensitivity of cassova nodes, 18: 33389
radiosensitivity of young mahogany, 18: 33389
radiosensitivity of young papaya, 18: 33389
TRIETHYLAMINE
effects on chemical equilibrium and rate of solvation of charge groups in aromatic compounds, 18: 33613
TRITIUM
determination in aqueous solutions, liquid scintillation spectrometer for, 18: 34274(R) (NIRS-2(p.3-15))
determination in helium-3 by scintillation counting, 18: 35246(R) (MLM-1196)
determination in urine, 18: 33518
determination in urine, 18: 33518
determination of, evaluation of liquid scintillation solvent systems for, 18: 33938
determination of, evaluation of elution gas chromatography as method for pre-enrichment for low-level counting in, 18: 34011
deuteron reactions (d,n) with, in titanium, 18: 34375
deuteron reactions at 25 to 500 kev, anisotropy factors for neutron yield in, 18: 34815
metabolism of, effects of chemical form on, 18: 33328
proton elastic scattering at 300 to 900 kev, differential cross sections for, 18: 34944
reactions of recoil atoms with isobutane, steric effect in displacement, 18: 33640
uptake by *Vicia faba* chromosomes, tracer study, 18: 33318
uptake of thymidine-incorporated, by human chromosomes in leukemia cells, 18: 33253
TRITONS
emission in oxygen-16 reactions with nuclei at 167 Mev, spectra of, 18: 34780 (UCRL-11349)
form factors, 18: 34912
interactions with nucleons, amplitudes for, 18: 34619
scattering by nuclei, diffraction mechanism for elastic, 18: 34848
TRYPSIN
radiation effects, 18: 33283(R) (TID-20889)
TUBERCULOSIS
frequency in Hiroshima, 18: 33225
TUBES
heat transfer characteristics of Inconel, 18: 35153(R) (SRO-103)
joining of, device for hermetic, 18: 33708(P)
neutron transmission through nickel-coated copper, 18: 34752(R) (CU(PNPL)-234)
tests of NPR steam generator tubing, 18: 35195 (HW-82233)
TUMORS
antibody localization in, tracer study of, 18: 33232(R) (NYO-910-3)
boron content in, 18: 33431 (TID-20856)
detection of metastatic, by whole-body scanning after administration of tracer dose of calcium-47 or strontium-85, 18: 33233(R) (NYO-910-9)
diagnosis of esophagus, by differential uptake of phosphorus-32, 18: 33438
radiation effects on human, *in utero* exposure, 18: 33391
radiosensitivity of lymphosarcoma cells in mice, effects of oxygen tension on, 18: 33379
radiotherapy of cervical, incidence of persistent or recurrent cancer, 18: 33444
radiotherapy of pelvic, factitial proctitis induced by, 18: 33330
radiotherapy of, computer dose distribution calculations for, 18: 33434
radiotherapy of, computer patient simulation for, 18: 33435
TUNGSTEN
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
analysis for carbon, hydrogen, iron, nitrogen, and oxygen, review of methods for, 18: 33516
analysis for hydrogen, nitrogen, and oxygen, vacuum fusion, 18: 33491
analysis for impurities, review of methods for, 18: 33515
bibliography on preparation, fabrication, and uses of, 18: 34151
conference on refractory metals, Oslo, Norway, June 23 to 26, 1963, 18: 34068
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
corrosion by zinc–molten halide system, 18: 33678(R) (ANL-6875)
corrosion resistance of, effects of alloying and coating on, 18: 34084
densification of fine-grained powder of, use of gas pressure for, 18: 34065
determination in silicon, activation, 18: 33502
determination of, tracer techniques for, 18: 33483
electronic structure, physical properties, and alloying properties, 18: 34202
fabrication of rocket-nozzle of, process of, 18: 34105
fabrication of, mechanical tests to evaluate, 18: 34101
fabrication of, review of primary working operations for, 18: 34104
fabrication, properties, and uses of, review on, 18: 34178

flow forming of, for rocket engine techniques, 18: 34109
forging in hydraulic presses, closed-die, 18: 34105
gamma coherent scattering at small angles, 18: 35053
heat transfer across contacting surface with graphite, 18: 33735 (MIT-2079-2)
ionization by electron and positron impact, 18: 34431
mechanical properties of, effects of trace elements on, 18: 34206
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
oxidation by air and gas mixtures, kinetics of, 18: 34083
physical properties of, effects of alloying additions and chemical reactions, 18: 34205
preparation and properties of bcc, 18: 34039(R) (GA-5340)
properties for use at high temperatures, 18: 34201
properties of, review on, 18: 34180
quenching behavior in helium, 18: 34138
radiation effects on single crystals of, 18: 34122(R) (GA-4900)
reactions with plutonium nitride, 18: 34032(R) (BMI-1668(Del.))
sheet bending of, methods and problems of, 18: 34107
sintering of powered, effects of cobalt, copper, iron, and nickel on rates of, 18: 34098
tensile properties of, effects of interaction of interstitial solute and substructure on, 18: 34204
tensile properties of, effects of interstitial and substitutional solutes on, 18: 34203
tensile properties of, method of testing, 18: 34210
thermal expansion to 2000°C, 18: 34190
thermophysical properties, 18: 34207
x-ray spectra of, precision redetermination of wavelength of $K\alpha_1$ line in, 18: 34341

TUNGSTEN ALLOY COUPLES
Re–W/Re–W, thermocouple drift at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)
Re–W/W, thermocouple drift at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)

TUNGSTEN ALLOYS
conference on refractory metals, Oslo, Norway, June 23 to 26, 1963, 18: 34068
development for high-temperature applications, review, 18: 34069
fabrication of, mechanical tests to evaluate, 18: 34101
properties of, review on, 18: 34180
welding of, embrittlement in, 18: 34108
Hf–Nb–W–Y, welding of C-129Y, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Mo–W, corrosion by zinc–molten halide system, 18: 33678(R) (ANL-6875)
Mo–W, phase studies based on thermochemical data, 18: 33603
Nb–Ta–W, welding of SCb-291, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Nb–Ta–W–Zr, coating of FS-85, with palladium–platinum alloy and platinum, 18: 34029(R) (AD-601740)
Nb–Ta–W–Zr, welding of FS-85, electron-beam and tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Nb–W, tensile properties of, effects of carbon, vanadium, and zirconium on, 18: 34197
Nb–W–Zr, fabrication and properties of Cb-752 sheet, 18: 34025(R) (AD-428036)
Nb–W–Zr, welding of Cb-752 and D-43, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Ta–W, fabrication and properties of, effects of carbon, hafnium, molybdenum, nitrogen, rhenium, and zirconium additions on, 18: 34059(R) (WANL-PR(Q)-003)
Ta–W, welding of, electron-beam and tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)

TUNGSTEN CARBIDES
grinding, 18: 34095
Co–WC, grinding, 18: 34095

TUNGSTEN COUPLES
Re/W, compatibility with plutonia–urania systems, 18: 35146(R) (GEAP-4601)
Re–W/W, thermocouple drift at high temperatures in vacuum, 18: 33833 (ORNL-TM-883)

TUNGSTEN CYANIDE COMPLEXES
oxidation by cerium, iridium chloride, and iron and molybdenum cyanides, electron-transfer reactions in, 18: 33550

TUNGSTEN ISOTOPES
separation in calutrons, 18: 34005(R) (ORNL-TM-879)
separation of stable, in calutrons, 18: 34005(R) (ORNL-TM-879)

TUNGSTEN ISOTOPES W-180
energy levels of, measurement of lifetime of first excited, 18: 34772 (NP-14184)

TUNGSTEN ISOTOPES W-182
energy levels of, parity and spin of excited, 18: 34953
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950

TUNGSTEN ISOTOPES W-184
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950

TUNGSTEN ISOTOPES W-186
nucleon vibrational-rotational interactions in, 18: 34950

TUNGSTEN ISOTOPES W-187
analytical uses, 18: 33483
beta decay of, electron spectra from, 18: 34804

TUNGSTEN OXIDES
exchange reactions with oxygen-18, mechanism of, 18: 33545

TUNGSTEN SYSTEMS
Mo–Si–W, deposition on D-14 niobium alloy, 18: 34052 (RTD-TDR-63-4063)
W–UO_2, tensile fracture stress of pneumatically impacted, 18: 34124 (HW-79676)

TURBINES
design and development of turbogenerator for space vehicle electric power systems, 18: 35197(R) (64SD700)
design of, for nuclear applications, 18: 33753
development for nuclear space propulsion systems, 18: 35216

TURTLES
iodine-131 incorporation by, 18: 33254

U

ULTRASONICS
attenuation in electron gas and metals, 18: 34454
testing with, nondestructive, 18: 35208
use in superconducting energy gap determination, 18: 34701
uses for detecting foam–water interfaces, 18: 33831(R) (NYO-10558)
uses for interface-detecting and level-indicating instruments, 18: 33830(R) (NYO-10556)
uses in interface-detecting, level-indicating, and thermometric instruments, 18: 33832(R) (NYO-10560)
uses in microsampling techniques for irradiated fuel cores, 18: 35146(R) (GEAP-4601)

ULTRAVIOLET RADIATION
chemical effects on potassium azide, 18: 33647
detection of, photomultipliers for, 18: 33904
detection of, photomultipliers for, 18: 33905
detection of, scintillation detectors for, 18: 33908
effects on lysozyme amino acid content and inactivation, 18: 33295
effects on phenylalanine uptake by polyuridylic acid, chemical and photoreactivation effects on, 18: 33392
effects on structure of nucleic acids, 18: 33277 (STI/DOC/10/28(p.21-38))
effects on thymine dimer excision from *E. coli* DNA, 18: 33298
emission from helium plasma, 18: 35012
mutations induced in homozygote and isogenic Saccharomyces yeast strains by, ploidy effects on, 18: 33394

UNDERGROUND EXPLOSIONS
detection and identification of, techniques for, 18: 34251
detection of nuclear, by on-site earth resistivity and self-potential measurements, 18: 33780 (NP-14145)
mining broken rock from nuclear, 18: 33710
radionuclide distribution around cavity from, analysis of, 18: 33766 (HNS-1229-47)
use in creating subterranean chamber for submarine testing, feasibility of, 18: 33709 (SC-TM-64-636)

UNDERGROUND STRUCTURES
design of simple bomb shelter, 18: 33758(P)

UNITED STATES
cerium-144 and cesium-137 in wheat of, 18: 33818
radiation dose to population of, diagnostic, 18: 33419

URACIL
5-ribosyluracil-5'-monophosphate synthesis in *Tetrahymena pyriformis*, 18: 33246

URANINITES
carbonate–uraninite veins, calcite–anthraxolite metasomatosis in, 18: 33795

URANIUM
abundance in solar system, 18: 34401
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
conductivity of, electric and thermal, 18: 34143
content in Panamint Range zircons, 18: 33793
corrosion by water, effects of oxygen on, 18: 34072 (AWRE-O-40/64)

determination alone and in mixtures with cerium, iron, manganese, and vanadium using potassium dichromate, titrimetric, 18: 33496
determination in MSRE fuel salts, 18: 34050(R) (ORNL-3626(p.59-164))
determination in urine by fluorescence, 18: 33506
determination in urine, 18: 33518
determination of, spectrophotometric, 18: 33463 (JEN-139-DQ/I-43)
effects on neutron-irradiation effects on superconductors, 18: 34683(R) (NP-14136)
electric conductivity of alpha-, at 2 to 300°K, 18: 34164
electric conductivity at 300°K, reduced Ziman, 18: 34164
electrodeposition on platinum and stainless steel, 18: 34007(R) (ORNL-TM-890)
electron reactions (e,n) at 16 Mev, neutron spectra of, 18: 34945
excretion of, in urine, 18: 33268
fabrication techniques for, 18: 34085(R) (BRB-81)
fluorescence in sodium carbonate–sodium fluoride melts, effects of impurities on, 18: 33506
gamma coherent scattering at small angles, 18: 35053
heat contents of gamma-phase and liquid, at 1205 to 1394 and 1415 to 1579°K, 18: 33553
metabolism by algae, 18: 35238 (STI/DOC/10/28(p.9-20))
metallography, visual standards for estimating recrystallization, inclusions, and stringers, 18: 34047 (NLCO-910)
mining of, cancer mortality from, 18: 33813
neutron flux distributions in multiplying and non-multiplying systems of, pulsed, 18: 34738
neutron lifetimes in assemblies of cylinders of, prompt, 18: 34496
photoelectric effect in, relativistic, 18: 34847
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
preparation from uranium tetrafluoride, process for, 18: 33611(P)
processing reactor-fuel, pyrometallurgical processes for, 18: 33683 (TID-8540(p.411-76))
production by electrorefining in molten salt bath, effects of iron on, 18: 34093
properties as reactor fuel, 18: 34130 (TID-8540(p.331-410))
radioinduced creep in alpha-phase, 18: 34130 (TID-8540(p.331-410))
reactions with steam, reactor safety studies of, 18: 33678(R) (ANL-6875)
separation by solvent extraction using tributyl phosphate–methyl isobutyl ketone, effects of salts on, 18: 33679 (JEN-136-DQ/I-40)
separation by solvent extraction using tributyl phosphate–ethyl acetate, effects of salts on, 18: 33680 (JEN-137-DQ/I-41)
separation by solvent extraction using tributyl phosphate–inert solvent systems, effects of solvents on, 18: 33681 (JEN-138-DQ/I-42)
separation from rare earths, zirconium, and other elements by paper chromatography, 18: 33505
solubility in cadmium–magnesium–zinc alloys, 18: 33678(R) (ANL-6875)
solvent properties for uranium nitride at 1133 to 2880°C, 18: 34035(R) (BMI-X-10053)
thermal conductivity of powdered, 18: 33678(R) (ANL-6875)
toxic effects of, in man, 18: 33268

URANIUM ALLOYS
processing reactor-fuel, pyrometallurgical processes for, 18: 33683 (TID-8540(p.411-76))
properties of dilute, as reactor fuels, 18: 34130 (TID-8540(p.331-410))
Al–Ni–U, reactions with steam, reactor safety studies of, 18: 33678(R) (ANL-6875)
Al–U, oxidation kinetics of intermetallic compounds in, 18: 34077
Al–U, properties as reactor fuel, 18: 34130 (TID-8540(p.331-410))
Be–Th–U, compatibility with Inconel, niobium, stainless steel, and tantalum at 1500°F, 18: 34032(R) (BMI-1668(Del.))
Be–Th–U, compatibility with metals and alloys at 1000 and 1500°F, 18: 34033(R) (BMI-1669(Del.))
Be–Th–U, compatibility with metals and alloys at 1500 and 2000°F, 18: 34034(R) (BMI-1672(Del.))
Mo–U, electric and thermal conductivity of, 18: 34143
Mo–U, properties as reactor fuel, 18: 34130 (TID-8540(p.331-410))
Nb–U, properties as reactor fuel, 18: 34130 (TID-8540(p.331-410))
Nb–U, structure of, effects of cooling rate from gamma phase on, 18: 34127 (RT/MET(64)-2)
Nb–U–Zr, reactions of molybdenum with uranium in, 18: 34174
Pd–U, gadolinium EPR in, 18: 33587
Pu–U, burnup and recycling in light-water-moderated reactors, 18: 35128(R) (GEAP-4642)
Sb–U, thermoelectric properties of cubic intermetallic compounds in, 18: 34142
U–Zr, annealing irradiated, 18: 34234
U–Zr, properties as reactor fuel, 18: 34130 (TID-8540(p.331-410))
U–Zr, structure of, effects of cooling rate from gamma phase on, 18: 34127 (RT/MET(64)-2)

URANIUM ARSENIDES
thermoelectric properties of cubic, 18: 34142

URANIUM CARBIDES
diffusion of carbon in, at 1900 to 2050°C, 18: 34033(R) (BMI-1669(Del.))
fission gas release from arc-cast mono-, 18: 34032(R) (BMI-1668(Del.))
fission product release from, in TREAT, 18: 35247(R) (NAA-SR-9700)
oxidation, 18: 35247(R) (NAA-SR-9700)
preparation of pure single crystals of, 18: 35247(R) (NAA-SR-9700)
thermal conductivity of mono-, at temperatures up to 1600°C, 18: 34120 (CNLM-5621)
thermal conductivity, 18: 34172
thermoelectric properties of cubic, 18: 34142
vaporization of mono-, at 2190 to 2525°K, 18: 33523 (CNLM-5619)
PuC–UC, preparation, 18: 33678(R) (ANL-6875)
PuC–UC, radiation effects on, 18: 34032(R) (BMI-1668(Del.))
PuC–UC, radiation effects on, 18: 34033(R) (BMI-1669(Del.))
PuC–UC, radiation effects on, 18: 34034(R) (BMI-1672(Del.))
UC–UN, stability of solid solutions of, 18: 33576
UC–US, fabrication, 18: 35060(R) (ANL-6904)
U–UC, preparation of cermet compacts of, 18: 34115(P)
U–UC–UO_2, binary eutectic in, 18: 34144

URANIUM(III) CHLORIDES
yields in reduction of tetrachloride by carbon monoxide, calculations of, 18: 33530 (ORNL-TM-829)

URANIUM(IV) CHLORIDES
reduction to trichloride by carbon monoxide, thermodynamics of, 18: 33530 (ORNL-TM-829)

URANIUM COMPOUNDS
analysis for copper, mercury, and silver by solvent extraction using dithizone, 18: 33509
preparation of pure, minerals, 18: 33599
thermoelectric properties of cubic monovalent, 18: 34142

URANIUM(III) FLUORIDES
solubility and stability in molten-fluoride-salt mixtures, 18: 34050(R) (ORNL-3626(p.59-164))

URANIUM(IV) FLUORIDES
reduction in closed bombs, metallothermic, 18: 33542
reduction to metal, 18: 33611(P)
BeF_2–LiF–ThF_4–UF_4–ZrF_4, radiation effects on, 18: 34050(R) (ORNL-3626(p.59-164))

URANIUM IONS
determination in MSRE fuel salts, 18: 34050(R) (ORNL-3626(p.59-164))
exchange with uranium(VI) in acidic-cation exchange resin system, 18: 33577

URANIUM ISOTOPES
determination by emission spectrometry, development of luminous sources for, 18: 33459 (CEA-R-2428)
determination in irradiated thorium, 18: 33462 (DP-883)
radiation hazards from deposited, in man, 18: 33268
separation of, electromagnetic, 18: 34005(R) (ORNL-TM-879)

URANIUM ISOTOPES U-232
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950
properties for use as heat source in direct conversion devices, 18: 34002

URANIUM ISOTOPES U-233
fission of, cluster-model, 18: 34872

URANIUM ISOTOPES U-234
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950
separation from plutonium-238 solutions by anion exchange and solvent extraction, 18: 35246(R) (MLM-1196)
spin of, Coriolis anti-pairing and blocking effects on, 18: 34775 (TID-20875)

URANIUM ISOTOPES U-235
age measurements in ratio with lead-207 in uranium ores on Colorado Plateau, 18: 33796
alpha decay of, half life for, 18: 34752(R) (CU(PNPL)-234)
determination in fuel rods, statistical method for evaluating counting data in nondestructive, 18: 34044 (NAA-SR-9600)
determination in irradiated fuel elements, alpha spectroscopic, 18: 35065 (STI/DOC/10/28(p.67-71))
fission by thermal neutrons, yields of cesium-137 from, 18: 33678(R) (ANL-6875)
fission of, cluster-model, 18: 34872
fission products of, ionization in argon–methane by, 18: 33895
neutron capture-to-fission ratio of, at 12 to 690 kev, 18: 34886
neutron fission at 0.003 ev to resonance energies, 18: 34752(R) (CU(PNPL)-234)
neutron fission rates of, fine structure in, 18: 35060(R) (ANL-6904)
separation at Pierrelatte, France, 18: 34010

URANIUM ISOTOPES U-236

neutron cross sections for, 1-kev to 15-Mev, 18: 34750 (AWRE-O-30/64)
URANIUM ISOTOPES U-237
beta decay of recoilless gamma emission after, 18: 34920
URANIUM ISOTOPES U-238
age measurements in ratio with lead-206 in uranium ores on Colorado Plateau, 18: 33796
energy levels of, vibration-rotation interactions in, 18: 34846
neon-20 reactions (Ne-20, Ne-24) with, angular distributions in, 18: 34763 (JINR-P-1675)
neutron fission rates of, fine structure in, 18: 35060(R) (ANL-6904)
neutron inelastic scattering by, analysis of, 18: 34910
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
neutron resonance integrals, 18: 35247(R) (NAA-SR-9700)
nucleon vibrational-rotational interactions in, 18: 34950
spin of, Coriolis anti-pairing and blocking effects on, 18: 34775 (TID-20875)
URANIUM ISOTOPES U-239
beta decay, 18: 34850
URANIUM MINERALS
carbonate–uraninite veins, calcite–anthraxolite metasomatosis in, 18: 33795
processing for pure compound production, 18: 33599
URANIUM NITRATES
plutonium nitrate–uranium nitrate, reactions with ammonium hydroxide to produce (plutonium–uranium) dioxide, 18: 35146(R) (GEAP-4601)
URANIUM NITRIDES
compatibility with cladding metals, 18: 34035(R) (BMI-X-10053)
development, 18: 34035(R) (BMI-X-10053)
fabrication, 18: 34035(R) (BMI-X-10053)
oxidation by oxygen at 300 to 450°C, kinetics, 18: 34035(R) (BMI-X-10053)
solubility in liquid uranium at 1133 to 2880°C, 18: 34035(R) (BMI-X-10053)
thermal decomposition of mono-, 18: 33524 (CNLM-5620)
thermoelectric properties of cubic, 18: 34142
UC–UN, stability of solid solutions of, 18: 33576
URANIUM ORES
origin of Colorado Plateau, lead–uranium isotopic ages measurement for evidence on, 18: 33796
URANIUM OXIDES
fluorination by fluidized-bed methods, 18: 33678(R) (ANL-6875)
separation of iodine-131 from irradiated, by distillation, 18: 33620 (NP-14187)
thermodynamic properties of equilibrium mixtures of, 18: 33546
URANIUM(IV) OXIDES
characterization of spheroidal particles of, for use in stainless steel-dispersion fuel plates, 18: 34088 (ORNL-3645)
density of sintered, effects of niobium and titanium oxides on, 18: 35060(R) (ANL-6904)
fabrication and properties of sintered, 18: 34049(R) (NUMEC-P-106)
fabrication of fuel elements of, by vibratory compaction, 18: 34096
fission gas release from sintered pellets of, postirradiation annealing studies, 18: 34214 (EURAEC-1126)
fluorination, 18: 33678(R) (ANL-6875)
grain growth and solarization of sintered pellets of, effects of organic binders on, 18: 34170
grain size of sintered, effects of niobium oxide on, 18: 35060(R) (ANL-6904)
neutron resonance integrals for, temperature dependence of, 18: 34741
oxidation by oxygen at high temperatures, 18: 34049(R) (NUMEC-P-106)
powder compaction of, as function of specific surface, 18: 34094
preparation of active, 18: 33533 (UJV-725/63)
preparation of hydrothermally stable sols of, 18: 33609(P)
preparation of sols of, 18: 33608(P)
preparation of, using dry steam, 18: 33606(P)
processing into reactor fuel tubes, 18: 35143(R) (DP-915)
production of crystals of, by electrolysis of uranyl chloride in molten salt, 18: 33607(P)
properties as reactor fuel, 18: 35127(R) (GEAP-3771-13)
radiation effects on thermal conductivity of pellets of, effects of central melting on, 18: 34215 (GEAP-4624)
reactions with carbon for preparation of uranium–uranium carbide cermets, 18: 34115(P)
sintering process, 18: 34048 (NP-14124)
solvent properties for helium at 1200 and 1300°C, 18: 34055 (UCRL-11043)
thermal conductivity, 18: 34172
thermal properties of, effects on reactor transients, 18: 35146(R) (GEAP-4601)
B_4C–UO_2, properties of vibratory-compacted, 18: 35126(R) (CEND-3107-216)
BeO–ThO_2–UO_2–Y_2O_3, fuel retention at high temperatures, 18: 34040(R) (GEMP-36A)
BeO–ThO_2–UO_2–Y_2O_3, mechanical and thermal properties of, 18: 34040(R) (GEMP-36A)
BeO–UO_2, fission gas release from irradiated dispersion of, 18: 34033(R) (BMI-1669(Del.))
BeO–UO_2, fission gas release from irradiated, at 1200 to 1600°C, 18: 34034(R) (BMI-1672(Del.))
PuO_2–UO_2, compatibility with rhenium/tungsten couples, 18: 35146(R) (GEAP-4601)
PuO_2–UO_2, development and testing of fuels of, 18: 35146(R) (GEAP-4601)
PuO_2–UO_2, fabrication and properties of sintered, effects of silicon oxide additions on, 18: 34049(R) (NUMEC-P-106)
PuO_2–UO_2, oxidation by oxygen at 400 to 1400°C, 18: 34049(R) (NUMEC-P-106)
PuO_2–UO_2, phase studies, 18: 35146(R) (GEAP-4601)
PuO_2–UO_2, preparation and properties of coprecipitated powders of, 18: 34049(R) (NUMEC-P-106)
PuO_2–UO_2, preparation from mixed nitrates, 18: 35146(R) (GEAP-4601)
PuO_2–UO_2, reactivity temperature coefficients of fuels of, 18: 35114(T) (ORNL-tr-263)
ThO_2–UO_2–Y_2O_3, phase studies, 18: 34040(R) (GEMP-36A)
U–UC–UO_2, binary eutectic in, 18: 34144
U–UO_2, phase studies, 18: 33678(R) (ANL-6875)
W–UO_2, tensile fracture stress of pneumatically impacted, 18: 34124 (HW-79676)
URANIUM(IV-VI) OXIDES
use as catalyst in oxidation of exhaust gases from internal combustion engines, 18: 33610(P)
URANIUM(VI) OXIDES
preparation of, using dry steam, 18: 33606(P)
URANIUM PEROXIDES
spectra of tetrahydrate of, proton magnetic resonance, 18: 33602
URANIUM PHOSPHIDES
fabrication and properties, 18: 35060(R) (ANL-6904)
thermoelectric properties of cubic, 18: 34142
URANIUM POISONING
hazards of, from inhalation of dusts, 18: 33268
URANIUM SELENIDES
thermoelectric properties of cubic, 18: 34142
URANIUM SILICIDES
use in refractory fuel material, 18: 34071(P)
URANIUM SULFIDES
preparation, 18: 33678(R) (ANL-6875)
thermoelectric properties, 18: 33678(R) (ANL-6875)
thermoelectric properties of cubic, 18: 34142
UC–US, fabrication, 18: 35060(R) (ANL-6904)
URANIUM SYSTEMS
Al–C–Mo–Ni–Si–U–Zr, preparation and fabrication as refractory fuel material, 18: 34071(P)
B–Th–U, compression tests of $(Th,U)B_4$, 18: 34034(R) (BMI-1672(Del.))
C–N–U, phase diagram and stability of, 18: 33576
C–Th–U, compatibility with Inconel and stainless steel, 18: 34034(R) (BMI-1672(Del.))
graphite–uranium, reactivity temperature coefficients in lattices of, 18: 35118
H–U, thermal neutron spectrum of, 18: 34734
N–U, phase diagrams, 18: 34035(R) (BMI-X-10053)
U–H_2O, criticality of slightly enriched, 18: 35113 (TID-8540(p.529-609))
U–UC, preparation of cermet compacts of, 18: 34115(P)
U–UC–UO_2, binary eutectic in, 18: 34144
U–UO_2, phase studies, 18: 33678(R) (ANL-6875)
U–ZrH, fission product release from irradiated SNAP 10A/2 fuel, 18: 34045 (NAA-SR-9673)
URANYL ACETATES
effects on reactivation of uv irradiated polyuridylic acid, 18: 33392
URANYL CHLORIDES
electrolysis in molten salt for production of uranium dioxide crystals, 18: 33607(P)
spectra of, effects of solvent and temperature on absorption, 18: 33678(R) (ANL-6875)
thermal decomposition at 650°C, 18: 33678(R) (ANL-6875)
URANYL FLUORIDES
preparation of, using dry steam, 18: 33606(P)
URANYL IONS
binding to bovine serum albumin-stabilized emulsions, 18: 33575
precipitation and/or uptake by zirconium hypodiphosphate in hydrochloric acid, 18: 33600
separation from zirconium by ion exchange on pyrocatechol-*O,O*-diacetic

acid, 18: 33508
structure, 18: 33520 (AD-436582)
URANYL NITRATES
catalytic effects on radioinduced polymerization of solid 3,3-*bis*-chloromethyloxatane, 18: 33651
effects on radiolysis of ketones, 18: 33621 (UJV-977/64)
photochemical reactions with tetrabutylammonium iodide, formation of tributyliodoammonium iodide in, 18: 33628
solvent extraction by ketones, radiation effects on, 18: 33621 (UJV-977/64)
UREA
radioinduced free radicals in fatty acid ester inclusion compounds with, ESR spectra and molecular motion of, 18: 33641
URIDINE
effects on recovery of irradiated mammalian cells, 18: 33275(R) (NYO-910-2)
URIDINE, 5-BROMO-2'-DEOXY-
effects on synthesis of nucleic acids and proteins, 18: 33212(R) (NYO-2570-1)
incorporation into DNA, 18: 33212(R) (NYO-2570-1)
protective effects against giant cell formation in HeLa animal cells, 18: 33405
URIDINES, 5-IODO-2'-DEOXY-
protective effects against giant cell formation in HeLa animal cells, 18: 33405
URIDINES, 2'-DEOXY-
effects on radiobiological, physical, and chemical properties of desoxyribonucleic acid, 18: 33402
URIDYLIC ACID
radiation effects on phenylalanine uptake by polymers of, chemical and photoreactivation effects on, 18: 33392
radiation effects on phenylalanine uptake by polymers of, chemical and photoreactivation effects on uv, 18: 33392
URINE
analysis for cesium-134 or cesium-137 in, 18: 33265
analysis for cesium-137, radiochemical, 18: 33449(R) (NIRS-2(p.15-19))
analysis for gamma-emitting radioisotopes, spectrometric, 18: 33264
analysis for plutonium, radiochemical, 18: 33677
analysis for uranium of, for estimation of internal contamination, 18: 33268
analysis for uranium by fluorescence, 18: 33506
analysis of, for radionuclides, 18: 33518
analysis of, radiochemical for, 18: 33519
cesium-137 content of human, 18: 33805(R) (NIRS-2(p.57-67))
excretion of plutonium in, of man, 18: 33267
potassium-42 excretion in human, factors affecting, 18: 33238
radiation effects on human, *in utero* exposure, 18: 33391
radiosensitivity prediction by potassium-sodium ratios in mouse, 18: 33321
UTERUS
radiotherapy of cervical carcinoma, incidence of persistent or recurrent cancer, 18: 33444

V

VACUUM GAGES
development of ultra-high, 18: 33761
operation of, effects of electron-surface interactions on, 18: 33759 (AD-427830)
performance and use of radiometric, 18: 33999
VACUUM PUMPS
development of ultra-high, 18: 33761
primer for evapor-ion, design of titanium, 18: 35258(P)
VACUUM SYSTEMS
design for Cambridge Synchrotron, 18: 34367 (CEAL-1000)
design for irradiation or vacuum-coating of specimens, 18: 33763(P)
design of ultra-high, 18: 33764(P)
development for microwave plasma components studies, 18: 34977(R) (RADC-TDR-64-94)
development of ultra-high, 18: 33761
VACUUM TECHNIQUES
book: *Vacuum Technology*, 18: 33762
development of ultra-high, 18: 33761
developments in ultrahigh, for surface kinetic studies, 18: 33454
VAGINA
radiation effects on cells of, 18: 33348
VALINE
incorporation into protein, 18: 33212(R) (NYO-2570-1)
VALLECITOS SUPERHEAT REACTOR
fuel development and testing for, 18: 35145(R) (GEAP-4566)
fuel elements of, mechanical out-of-pile testing of, 18: 35144 (GEAP-4560)
VALVES
design for glass blowing on contaminated apparatus, 18: 33718
development for flow of powdered or granular solids, 18: 33712 (HW-53440)
VAN ALLEN RADIATION BELTS
effects on manned space flight, computer analyses of, 18: 35048 (AMRL-TDR-64-11)
VAN DE GRAAFF ACCELERATORS
design of 600-kv, 18: 34373(T) (JPRS-25692)
VANADIUM
determination in mixture with uranium using potassium dichromate, titrimetric, 18: 33496
determination of, tracer techniques for, 18: 33483
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
effects on structure of superconducting Nb_3Al, 18: 34283 (UCRL-11390)
effects on tensile properties of niobium–tungsten alloys, 18: 34197
fabrication and properties for use as superconductors, 18: 34179
fabrication of powdered, method for, 18: 34117(P)
gamma reactions (γ,n) with, neutron angular distribution from, 18: 34935
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
tensile properties of, effects of interaction of interstitial solute and substructure on, 18: 34204
VANADIUM ALLOYS
fabrication and properties for use as superconductors, 18: 34179
Ga–V, properties for use as superconductive wires, 18: 34200
Ga–V, radiation effects of neutrons on superconductivity of, 18: 34683(R) (NP-14136)
Mo–Nb–V–Zr, properties of B-66 foils at high temperatures, effects of coatings on mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)
Mo–Nb–V–Zr, welding of B-66, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Sn–V–Zr, corrosion by steam at 350, 400, and 480°C, hydrogen sorption during, 18: 34060(T,R) (EURAEC-1062)
Sn–V–Zr, fabrication and mechanical properties, effects of heat treatments on, 18: 34060(T,R) (EURAEC-1062)
Ti–V, development for use as cladding on fast reactor fuels, 18: 35060(R) (ANL-6904)
VANADIUM ISOTOPES V-48
analytical uses, 18: 33483
VANADIUM ISOTOPES V-51
deuteron elastic scattering at 8.0 to 10.5 Mev, analyses of, 18: 34758 (JEN-130-DF/1-41)
energy levels, 18: 34855
proton reactions (p,n) at 7 to 13 Mev, 18: 34859
VANADIUM SYSTEMS
Si–V, radiation effects of neutrons on superconductivity of, 18: 34683(R) (NP-14136)
VELA PROJECT
development of geoelectric techniques for on-site inspection, 18: 33780 (NP-14145)
VELOCITY
measurement of reactor-coolant, 18: 35089 (TID-8540(p.177-211))
VINYL ALCOHOL POLYMERS
binder effects on grain growth and solarization of sintered uranium dioxide pellets, 18: 34170
VIRIAL COEFFICIENTS
calculation of fourth, from square-well potentials, 18: 34300
VISCOMETERS
design for high pressures and temperatures, 18: 33858
VISION
radiation effects on, in man, 18: 33341
VITAMIN B_1
protective effects against radiation effects on amino acid content in wheat sprouts, 18: 33398
VITAMIN D
effects on mineral content of bones and teeth in normal and rachitic rats, 18: 33277 (STI/DOC/10/28(p.21-38))
VITAMIN K
effects on hemorrhagic diathesis in rats fed irradiated beef, 18: 33992
VOLATILITY SEPARATION PROCESSES
development of fluid-bed chlorination-fluorination process for uranium alloy fuels, 18: 35060(R) (ANL-6904)
VOLCANOES
lead-210 from Mount Vesuvius, specific activity of, 18: 33791
VOLTAMMETRY
developments in controlled-potential, at ORNL, 18: 33452 (ORNL-P-145)
VOLTMETERS

development using ionization method for measuring contact potential differences, 18: 33863

W

WARFARE
civilian defense in atomic, 18: 33814
WASTE DISPOSAL
marine, effects on radioactivity of marine organisms, 18: 33230
marine, effects on radioactivity of organisms and water, 18: 33779
storage in buried tanks, heat dissipation from, 18: 35234(R) (HW-81862)
WASTE PROCESSING
calcination and solidification of high-level Purex and Redox wastes, development of equipment and techniques for, 18: 35234(R) (HW-81862)
development of methods for cesium-137 removal from sodium ion-containing wastes, 18: 34006(R) (ORNL-TM-889)
fixation in phosphate glass, laboratory studies, 18: 35236 (ORNL-3612)
ion exchange and solvent extraction methods for Purex wastes, 18: 35234(R) (HW-81862)
ion exchange separation of chromium-51 and cobalt-60 from citrate and permanganate solutions, 18: 35235 (IDO-12036)
review, 18: 35239
separation of radioisotopes for use as heat sources, 18: 33983 (HW-SA-3080(Rev.))
solidification by rising-liquid-level (RL-Potglass) process, 18: 35237 (ORNL-3629)
systems for boiling reactor gases, 18: 35181
WASTE SOLUTIONS
radioactive, effects of marine disposal on contamination of fish, 18: 33248
radioactive, effects on biological conditions in rivers, 18: 35238 (STI/DOC/10/28(p.9-20))
separation of strontium-90 from organic, by ion exchange, 18: 35240
WATER
analysis for metallic impurities by atomic absorption spectrometry, 18: 33461 (DP-879)
analysis for radioisotope traces, gamma spectrometric, 18: 33485
boiling burnout in ducts, survey of experimental data on, 18: 35162 (TID-8540(p.131-76))
boiling burnout studies, 18: 33737 (ORNL-P-18)
content in leda clay, calibration of neutron meter for measuring, 18: 33897
content in rhyolitic lava, 18: 33788
contents in meteorites, 18: 34398
corrosive effects on uranium, effects of oxygen on, 18: 34072 (AWRE-O-40/64)
corrosive effects on construction materials under ATR conditions, 18: 34074 (IDO-24460)
detection of surfaces of boiling, ultrasonic instruments for, 18: 33830(R) (NYO-10556)
detection of surfaces of boiling, ultrasonic instruments for, 18: 33831(R) (NYO-10558)
detection of surfaces and voids in boiling, ultrasonic instruments for, 18: 33832(R) (NYO-10560)
determination in friable materials, neutron meter for, 18: 33466(T) (AEC-tr-6399(p.43-50))
determination in friable bodies by neutron slow-down, 18: 33470(T) (AEC-tr-6399(p.83-91))
determination of traces of, in organic liquids, using kryptonates, 18: 33450(R) (NYO-2757-4)
deuterium exchange with hydrogen in, poisoning of platinum–carbon catalyst during, 18: 33527 (IFA-28-IS)
effects on radiolysis of ketones, 18: 33621 (UJV-977/64)
exchange reactions with heavy water, thermodynamic functions of, 18: 33567
flow through heat exchangers, total-sample method for measuring rate of, 18: 33750
gamma transmission through slabs of, 18: 35051
neutron diffusion and thermalization in spheres of, 18: 34752(R) (CU(PNPL)-234)
neutron flux distributions in, from point source in spherical cavity, 18: 34731 (NASA-CR-54110)
neutron scattering by, kernel including anisotropic molecular motion for, 18: 34739
neutron spectra in, with absorbers, 18: 34733
purification by ion exchange, 18: 33713
radium-226 content of drinking, maximum permissible limits for, 18: 33820
reactions with aluminum and its alloys, 18: 35060(R) (ANL-6904)
reactions with methyl iodide, calculated carbon-13 and deuterium isotope effects in, 18: 33612 (BNL-8066)
reactions with sodium, thermodynamics of, 18: 33528 (NP-14080)
separation from air and steam, development of centrifugal separators for, 18: 33693(R) (ACNP-64026)
separation of strontium from, method for, 18: 33484
$HF–H_2O$, phase equilibria with molten fluoride salts, 18: 34050(R) (ORNL-3626(p.59-164))
$H_2O–D_2O$, analysis, infrared interference method for isotopic, 18: 33460 (CEA-R-2440)
phenol–H_2O, compound formation in, 18: 34131 (TID-20849)
steam–H_2O, pressure drop in forced boiling flow, 18: 33745
steam–water, burnout heat flux in annulus, 18: 33730 (AERE-R-4352)
$U–H_2O$, criticality of slightly enriched, 18: 35113 (TID-8540(p.529-609))
WATER-*d*,
analysis for hydrogen, spectrometric, 18: 33539
beta scattering by, measurement of saturated backscattering from, 18: 35057
effects on rats, 18: 33250
exchange reactions with water, thermodynamic functions of, 18: 33567
production, bibliography on, 18: 34008 (TID-3091(Suppl.1))
$H_2O–D_2O$, analysis, infrared interference method for isotopic, 18: 33460 (CEA-R-2440)
WATER COOLED REACTORS
criticality studies of, with plutonium recycling, 18: 35168
design feasibility of heavy-water-moderated, up to 8300 Mw(th), 18: 35143(R) (DP-915)
excursions in, pressure pulses and voids from, 18: 35068(R) (STL-6312)
optimization of power, 18: 35179
review and survey of commercial power, 18: 35160 (TID-8540(p.1-69))
safety hazards in, evaluation of metal-water reactions as, 18: 33678(R) (ANL-6875)
WATER MODERATED REACTORS
criticality studies of, with plutonium recycling, 18: 35168
fuel recycling in plutonium–uranium fueled, 18: 35128(R) (GEAP-4642)
WATER PURIFICATION EQUIPMENT
design for reactor feed water purification, 18: 33713
WATER SUPPLIES
effects of high-altitude explosions on, evaluation on, 18: 33811
WATER VAPOR
condensation of, irreversible, 18: 34323
determination in argon in gas chromatography, electron drift velocity detector for, 18: 33476
WELDED JOINTS
mechanical properties, 18: 34089(T,R) (EURAEC-915)
WELDING
book: *Welding and Brazing Techniques for Nuclear Reactor Components*, 18: 34100
characteristics and developments in electron beam, 18: 34112
electron-beam and T1G, equipment and techniques for, 18: 34058(R) (WANL-PR(P)-003)
of aluminum, beryllium, and magnesium, characteristics of electron beam, 18: 34112
of refractory metals, electron beam, 18: 34092
techniques for thick steels, 18: 34089(T,R) (EURAEC-915)
WELDING RODS
properties of steel, 18: 34089(T,R) (EURAEC-915)
WELDS
defects in, effects of, 18: 35208
properties of steel filler, 18: 34089(T,R) (EURAEC-915)
WELL LOGGING
gamma, method for locating ore deposits, 18: 33782
radioactive, improvement of efficiency of data transmission in, 18: 33853(T) (AEC-tr-6399(p.207-20))
WETTING
detection in liquid sodium, apparatus for, 18: 33827 (EUR-1823.d)
WHEAT
cerium-144 and cesium-137 in United States, 18: 33818
radiation effects on amino acid content in sprouts of, protective effects of magnesium sulfate, niacin, and thiamin against, 18: 33398
radioinduced mutations of, yield from, 18: 33279(R) (TID-20823)
radioinduced mutations in, fast neutrons, 18: 33374
WIRES
radiation effects on performance of, in telemetry electronics, 18: 33839 (RTD-TDR-63-4287(Vol.II))
superconductive, properties of materials for, 18: 34200
WOOD
ion-exchange properties of products of, 18: 35238 (STI/DOC/10/28 (p.9-20))
WOUNDS
deuterium oxide effects on rat, 18: 33250

X

X AGENT
effects on neutral red precipitation or crystallization, 18: 33671
effects on neutral red precipitation or crystallization, 18: 33672
effects on neutral red precipitation or crystallization, 18: 33673

X RADIATION
aberrant effects on chromosomes in *Vicia faba*, 18: 33318
atherosclerosis induction by, in rabbits and man, 18: 33277 (STI/DOC/10/28(p.21-38))
biological effects in mice, rats, and dogs, 18: 33286(T) (UCRL-Trans-1068)
biological effects in rat and mouse embryos, effects of dose fractionation and protraction on, 18: 33423
chemical effects on potassium azide, 18: 33647
detection and measurement of small-wavelength cosmic, total-reflection telescope for, 18: 33970
detection of, photomultipliers for, 18: 33904
diffraction of, dynamical theory of, 18: 34354
dose distribution of, in tumors, computer analysis of data on, 18: 33434
effects of therapeutic doses of, on morphology of bone marrow cells, 18: 33399
effects on absorption spectra, electron emission, and luminescence of lithium fluoride crystals, 18: 33632
effects on ACTH and cortisone effects on phosphatide content and metabolism in rat testes, 18: 33256
effects on adrenalin and serotonin secretion in rats, 18: 33277 (STI/DOC/10/28(p.21-38))
effects on alkali halides, mechanism of defect formation and recombination in, 18: 34280(R) (NYO-2680-1)
effects on biological activity of snake venom, of *Ancistrodon piscivorus*, 18: 33385
effects on blood serum absorption and protein content in rats, 18: 33335
effects on bone composition in mice, 18: 33276(R) (NYO-910-7)
effects on conditioned reflexes in normal and bromide-treated dogs, 18: 33319
effects on cranial bones, 18: 33338
effects on dislocation motion in alkali halide crystals, acoustic attenuation study of, 18: 34276 (NP-14129)
effects on electrophoretic distribution of proteins in blood serum exposed *in vitro*, 18: 33353
effects on erythrocytes, 18: 33334
effects on expansion of melanophore pigment in hypophysectomized frogs, 18: 33277 (STI/DOC/10/28(p.21-38))
effects on fetuses in hamsters, 18: 33322
effects on fish pituitary control of melanization, 18: 33272(R) (NIRS-2(p.31-42))
effects on fish, protective effects of reserpine against, 18: 33272(R) (NIRS-2(p.31-42))
effects on fluorine-19-activated beryllium oxide, ESR spectra of, 18: 33657
effects on formation of lipid oxidation products in rat intestine, kidneys, and liver homogenate, 18: 33305
effects on Forssman-antigen synthesis in hamster and mouse cells, 18: 33317
effects on frog retina, 18: 33343
effects on fused chloride and fluoride salts, 18: 34050(R) (ORNL-3626(p.59-164))
effects on gastric retention in rats, 18: 33277 (STI/DOC/10/28(p.21-38))
effects on growth of barley seeds, effects of chlorides of sodium, calcium, and magnesium on, 18: 33409
effects on heme synthesis in rabbits, 18: 33400
effects on human chromosomes, 18: 33334
effects on immune reactions in rats, 18: 33387
effects on mice, protection against, 18: 33406
effects on mice, protective effects of histamine against, 18: 33414
effects on MPA metabolism in mice, 18: 33373
effects on mucopolysaccharides in rat connective tissue, 18: 33277 (STI/DOC/10/28(p.21-38))
effects on nervous system in cats and rats, 18: 33278 (STI/DOC/10/28(p.39-66))
effects on nuclei of mouse liver cells, 18: 33350
effects on nucleic acid synthesis in liver of partial-hepatectomized rats, whole-body, 18: 33294
effects on phagocytic activity of neutrophils in rabbits, 18: 33277 (STI/DOC/10/28(p.21-38))
effects on ploidy in Chinese hamster cell cultures, 18: 33383
effects on polarization of paraffin-sulfur mixtures, 18: 33622
effects on potassium levels in regenerating rat liver, 18: 33301
effects on rabbit typhoid immunity, 18: 33369
effects on radiation-resistant electronic equipment, 18: 33869
effects on rat adrenal cortex function, 18: 33272(R) (NIRS-2(p.31-42))
effects on rat blood proteolysis, 18: 33362
effects on rat liver, 18: 33380
effects on Saccharomyces, protective effects of RNA against, 18: 33410
effects on seed potato production, 18: 33376
effects on shape of dielectric hysteresis loop in triglycine sulfate, 18: 34242
effects on sister chromatid exchange in chromosomes of hamster cells in culture, 18: 33329
effects on skin graft acceptance in mice, effects of immune reactions on, 18: 33388
effects on skin graft acceptance in rabbits, effects of post-irradiation time on, 18: 33386
effects on structure of nucleic acids, 18: 33277 (STI/DOC/10/28(p.21-38))
effects on survival in fish, dose-dependence of, 18: 33272(R) (NIRS-2(p.31-42))
effects on toad embryos, protective effects of dinitrophenol against, 18: 33272(R) (NIRS-2(p.31-42))
effects on transformation of injected bone marrow cells in dogs, 18: 33337
effects on vision in man, 18: 33341
effects on zinc-65 uptake by mouse testes, 18: 33270(R) (NIRS-2(p.23-6))
emission by cadmium, $L\gamma_{\alpha}$, 18: 34411
emission from mesic (μ) atoms, energies for (2p-1s), 18: 34435
emission in meson (μ^-) transitions in carbon, 18: 34947
epilatory effects on young mice, effects of anoxia on, 18: 33408
free radical induction in alkyl ester-urea inclusion compounds by, ESR spectra and molecular motion of, 18: 33641
genetic effects in agricultural crop plants, 18: 33213 (STI/DOC/10/28(p.79-103))
genetic effects in bacteriophage, 18: 33278 (STI/DOC/10/28(p.39-66))
genetic effects in mouse populations, 18: 33281(R) (TID-20844)
genetic effects on maize and wheat, 18: 33279(R) (TID-20823)
gonadal doses from diagnostic, 18: 33419
histological effects on fish intestinal epithelium, 18: 33272(R) (NIRS-2(p.31-42))
histological effects on fish adrenal cortex, 18: 33272(R) (NIRS-2(p.31-42))
interactions with electrons in crystals, recoil resonance in, 18: 35242 (CALT-221-2)
lethal effects of 800-r doses on mice, protective effects of *N*-methyl-aminoethylthiosulfuric acid against, 18: 33418(P)
lethal effects on cancer cells, protective effects of AET against, 18: 33407
leukemogenic effects on mice, 18: 33311
measurement of, efficiency of counters for, 18: 33896
mutagenic effects in *Vicia faba*, 18: 33303
mutagenic effects in *Phaseolus mungo*, 18: 33324
mutations induced in homozygote and isogenic Saccharomyces yeast strains by, ploidy effects on, 18: 33394
pathologic effects on kidneys, 18: 33288
pathological effects of embryonic exposure to, in rats and mice, 18: 33280(R) (TID-20831)
photoeffect in cadmium sulfide single crystals, spectral distribution, 18: 34286(T) (AEC-tr-6399(p.186-95))
reactions with alkali halide crystals at 4 to 80°K, luminescence spectra from, 18: 33648
scattering by crystals, theory for, 18: 34452
scattering by lead, secondary electron emission from, 18: 34274(R) (NIRS-2(p.3-15))
scattering by silicon crystals, anti-Stokes and Stokes modified lines in, 18: 35242 (CALT-221-2)
scattering of, asymptotic expansion for integrals in, 18: 34022
therapeutic applications of, computer patient simulation for, 18: 33435
wavelengths of, silicon-crystal determination of absolute scale of, 18: 34340

X-RAY-ABSORPTION ANALYSIS
equipment for sulfur determination in liquid oil products, 18: 33472(T) (AEC-tr-6399(p.98-114))
of ash in coal and coke, 18: 33467(T) (AEC-tr-6399(p.51-60))

X-RAY BEAMS
energy of, determination of total, 18: 34274(R) (NIRS-2(p.3-15))

X-RAY-DIFFRACTION ANALYSIS
silicon-crystal measurement of absolute scale of x-ray wavelengths, 18: 34340
tables for radioactive-mineral, d spacing and intensity, 18: 33794 (NP-14176)

X-RAY EQUIPMENT
image-retaining panel for, evaluation of dental use of, 18: 33443

X-RAY SOURCES
development of strontium-90–yttrium-90-base, 18: 33989(T) (AEC-tr-6399(p.243-57))
X-RAY SPECTROSCOPY
precision redetermination of standard reference wavelengths, 18: 34341
silicon-crystal measurement of absolute scale of x-ray wavelengths, 18: 34340
XENON
crystal stability of, three-body interactions in, 18: 34706
diffusion in sintered uranium dioxide, activation energy of, 18: 34214 (EURAEC-1126)
ionization by shock waves, impurity effects on, 18: 34361
meson (π^-) reactions at 9 Bev/c, meson (π^0) production in, 18: 34949
rare-gas-ion scattering at 80 kev by, energy losses from, 18: 34416
reactions with inert-gas atoms, van der Waals forces for, 18: 34345
scattering by molecules at thermal energies, total cross sections for, 18: 34407 (UCRL-11071)
separation of krypton from, comparison of helium and nitrogen as carrier gas in chromatographic, 18: 35246(R) (MLM-1196)
xenon-129 NMR shift in, density dependence of, 18: 34919
XENON CHLORIDES
structure of, Mossbauer effect evidence for, 18: 33559
XENON FLUORIDES
preparation and melting point of pure hexavalent, 18: 33593
shielding anisotropies in, sign in, 18: 33558
Szilard-Chalmers effect in solid tetravalent, 18: 33666
XENON IONS
charge exchange in air, cross sections for, 18: 34409
XENON ISOTOPES
abundance in meteorites and natural gas, anomalies in, 18: 34399
content in Renazzo chondrite, 18: 34390
separation by thermal diffusion, 18: 35246(R) (MLM-1196)
XENON ISOTOPES Xe-126
energy levels of, measurement of lifetime of first excited, 18: 34772 (NP-14184)
XENON ISOTOPES Xe-129
nuclear magnetic resonance shift in xenon, density dependence of, 18: 34919

Y

YANKEE POWER REACTOR
control rod evaluation for, 18: 35165(R) (WCAP-6063)
fuel burnup distributions in, 18: 35165(R) (WCAP-6063)
operation and performance of, evaluation of, 18: 35175
YEASTS
effects of oxygen on role of oleic acid oxidation products in, 18: 33390
radiation and warming effects on *Saccharomyces cerevisiae* strains of, 18: 33393
radiation effects on role of oleic acid oxidation products in, 18: 33390
radiation effects on, protective effects of RNA against x, 18: 33410
radioinduced mutations in homozygote and isogenic Saccharomyces strains of, ploidy effects on, 18: 33394
YTTERBIUM
melting at high pressures, phase transitions in, 18: 34184
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
YTTERBIUM ISOTOPES
separation in calutrons, 18: 34007(R) (ORNL-TM-890)
YTTERBIUM ISOTOPES Yb-170
energy levels of, vibration-rotation interactions in, 18: 34846
nucleon vibrational-rotational interactions in, 18: 34950
YTTERBIUM ISOTOPES Yb-172
energy levels of, vibration-rotation interactions in, 18: 34846
spin of, Coriolis anti-pairing and blocking effects on, 18: 34775 (TID-20875)
YTTERBIUM ISOTOPES Yb-174
energy levels of, measurement of half life (850 μsec) of isomeric, 18: 34896
YTTRIUM
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
gamma reactions (γ,n) with, neutron angular distribution from, 18: 34935
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
separation from thorium and uranium by paper chromatography, 18: 33505
separation from zirconium by ion exchange on pyrocatechol-*O,O*-diacetic acid, 18: 33508
YTTRIUM ALLOYS
Be–Y, dissociation at high temperatures, 18: 34154
Ce–Y, properties and structure of, 18: 34160
Hf–Nb–W–Y, welding of C-129Y, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
La–Y, properties and structure of, 18: 34160
Mn–Hg–Y, preparation of amalgams of, 18: 34026 (AD-428771)
Mn–Hg–Y, preparation of amalgams of, 18: 34027 (AD-428772)
Mn–Y, structure of YMn_2 and YMn_{12}, 18: 34026 (AD-428771)
Mn–Y, structure of Laves phase YMn_2, 18: 34027 (AD-428772)
Ni–Y, gadolinium EPR in, 18: 33587
YTTRIUM ISOTOPES Y-89
deuteron reactions (d,p) at 12 Mev, 18: 34834
YTTRIUM ISOTOPES Y-90
beta decay of, internal bremsstrahlung from, 18: 34837
beta particles from, polarization of, 18: 34877
determination of physico-chemical state in liquid media, by paper electrophoresis and radioactivity recording, 18: 33590
energy levels, 18: 34834
metabolism by plankton, 18: 35238 (STI/DOC/10/28(p.9-20))
neutron-proton residual interaction in, 18: 34870
preparation and isolation of carrier-free, 18: 33665
YTTRIUM ISOTOPES Y-91
beta decay of, internal bremsstrahlung from, 18: 34837
sorption by river silts, 18: 35238 (STI/DOC/10/28(p.9-20))
YTTRIUM OXIDES
spectrum of erbium ions in single crystal, absorption and fluorescence, 18: 34305
$BeO–ThO_2–UO_2–Y_2O_3$, fuel retention at high temperatures, 18: 34040(R) (GEMP-36A)
$BeO–ThO_2–UO_2–Y_2O_3$, mechanical and thermal properties of, 18: 34040(R) (GEMP-36A)
$ThO_2–UO_2–Y_2O_3$, phase studies, 18: 34040(R) (GEMP-36A)
$Y_2O_3–Nb_2O_5$, properties and structure of compounds formed in, 18: 34199
$Y_2O_3–Ta_2O_5$, properties and structure of compounds formed in, 18: 34199
YTTRIUM ZIRCONATES
grain growth and sintering at 1600 to 2000°C, atmospheric effects on, 18: 34212

Z

ZINC
beta scattering by, measurement of saturation backscattering from, 18: 35057
content in human heart, neutron activation determination of, 18: 33457 (AE-146)
content in normal and leukemic leukocytes, activation analysis of, 18: 33517
determination in silicon, activation, 18: 33502
determination using cyclohexanediaminotetraacetic acid, potentiometric, 18: 33507
effects on fluorescence of uranium in sodium carbonate–sodium fluoride melts, 18: 33506
gallium atom ranges at low energies in, 18: 34441
gamma attenuation at 0.1 to 10 Mev, coefficients for, 18: 35058
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
radiodermatitis effects on content of, in skin and blood, 18: 33285(T) (JPRS-25502)
solvent partition in tributyl phosphate–hydrochloric acid or –nitric acid systems, 18: 33685
ZINC ALLOYS
Al–Zn, beta scattering from, 18: 35057
Cd–Mg–Zn, solubility of praseodymium and uranium in, 18: 33678(R) (ANL-6875)
Sn–Zn, beta scattering from, 18: 35057
Tc–Zn, phase studies and thermodynamic properties, 18: 33678(R) (ANL-6875)
ZINC ELECTRODES
electrolysis of solid lithium sulfate on, cathode reactions and isotope effects in, 18: 33596
ZINC IONS
production using laser light, 18: 34297
ZINC ISOTOPES Zn-65
gamma spectra of, least-squares analysis of, 18: 33926
radiation effects on mouse testicular uptake of, x, 18: 33270(R) (NIRS-2(p.23-6))
ZINC OXIDES
$MnZn(Fe_2O_4)_2$, neutron total cross section at 11.5 Å, 18: 34752(R) (CU(PNPL)-234)
positron annihilation in, angular correlations from, 18: 33605
ZIRCALOY-2

compatibility with uranium nitride at 900°C, 18: 34035(R) (BMI-X-20053)
corrosion by steam at 400°C, hydrogen sorption during, 18: 34060(T,R) (EURAEC-1062)
corrosion by steam and water in reactor environment, 18: 34076 (TID-8540(p.213-330))
corrosion of, effects of high heat flux on, 18: 34082
creep tests at 550 to 750°F, 18: 34032(R) (BMI-1668(Del.))
creep tests at 550 to 750°F, 18: 34033(R) (BMI-1669(Del.))
creep tests at 550 to 750°F, 18: 34034(R) (BMI-1672(Del.))
grain growth in high-temperature phase, 18: 34139
hydride platelet orientation in thin-walled tubing of, effects of fabrication and stresses on, 18: 35061(R) (DPST-64-83-6)
radiation effect on mechanical properties at 70 to 600°F, 18: 34233
reactions with iodine at 250 to 700°C, 18: 35127(R) (GEAP-3771-13)
welding to Inconel, explosive, 18: 34033(R) (BMI-1669(Del.))
welding to Inconel, explosive, 18: 34034(R) (BMI-1672(Del.))

ZIRCALOY-3
radiation effect on mechanical properties at 70 to 600°F, 18: 34233

ZIRCALOY-4
corrosion by steam and water in reactor environment, 18: 34076 (TID-8540(p.213-330))
radiation effect on mechanical properties at 70 to 600°F, 18: 34233

ZIRCONIUM
alpha elastic scattering at 24.7 Mev, relative cross sections for, 18: 34902
analysis for hydrogen using dosivac, 18: 34060(T,R) (EURAEC-1062)
analysis for hydrogen, equipment for, 18: 33511
analysis for sulfur, luminescent method for, 18: 33513
bibliography on preparation, fabrication, and uses of, 18: 34151
bonding by solid-state pressure, 18: 34034(R) (BMI-1672(Del.))
compatibility with beryllium–thorium–uranium alloy, 18: 34033(R) (BMI-1669(Del.))
crystal structure of alpha, effects of rare earth additions on, 18: 34053(R) (TID-20862)
crystal structure of, basal slip kink bands in, 18: 34193
determination in aluminum and magnesium alloys, photometric, 18: 33512
determination of, complexometric, 18: 33503
determination simultaneously with sulfur in organic compounds, amperometric, 18: 33514
determination using bromanilic acid, spectrometric, 18: 33498
diffusion of stabilized, mechanism of, 18: 34153
effects on tantalum–tungsten alloys, 18: 34059(R) (WANL-PR(Q)-003)
effects on tensile properties of niobium–tungsten alloys, 18: 34197
fabrication and properties for use as superconductors, 18: 34179
Fermi surface of, 18: 34185
grain growth in high-temperature phase, 18: 34139
ionization by electron and positron impact, 18: 34431
mechanical properties, effects of rare earths on, 18: 34053(R) (TID-20862)
neutron radiative capture cross sections at 30 and 65 kev, 18: 34274(R) (NIRS-2(p.3-15))
oxidation by oxygen at 700 to 2000°F, effects of rare earth additions on, 18: 34053(R) (TID-20862)
oxidation of sheets of, deformation in, 18: 34081
polarization in aqueous sulfate solutions, electrochemistry of passivating oxide film formed in, 18: 34063
precipitation with cerium–cadmium intermetallic compounds from liquid cadmium, 18: 34192
properties of, review on, 18: 34180
reactions with steam, reactor safety studies of, 18: 33678(R) (ANL-6875)
separation from metals by precipitation using triethanolamine, 18: 33503
separation from metals by ion exchange on pyrocatechol-*O,O*-diacetic acid, 18: 33508
separation from thorium and uranium by paper chromatography, 18: 33505
separation with fluoride from solutions containing hydrofluoric acid, uranium, and zirconium by precipitation, 18: 33690(P)
thermal expansion to 1450°C, 18: 34190

ZIRCONIUM ALLOYS
analysis for hydrogen, equipment for, 18: 33511
brazing into corrosion-resistant structures, brazing alloy for, 18: 34114(P)
fabrication and properties for use as superconductors, 18: 34179
properties as fuel element cladding in steam and water environments, 18: 34076 (TID-8540(p.213-330))
properties of, review on, 18: 34180
Cu–Zr, embrittlement effects of hydrogen on, 18: 34169
Fe–Zr, embrittlement effects of hydrogen on, 18: 34169
Mg–Zr, fine-grained structure in magnesium extruded, 18: 34182
Mn–Ti–Zr, magnetic moments and superconductivity of, 18: 34700
Mo–Nb–V–Zr, properties of B-66 foils at high temperatures, effects of coatings on mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)
Mo–Nb–V–Zr, welding of B-66, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Mo–Ti–Zr, coating of TZM, with palladium–platinum alloy and platinum, 18: 34029(R) (AD-601740)
Mo–Ti–Zr, properties of TZM foils at high temperatures, effects of coatings on mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)
Mo–Ti–Zr, tensile properties of TZM at room temperature and 650°C, 18: 35060(R) (ANL-6904)
Nb–Ta–W–Zr, coating of FS-85, with palladium–platinum alloy and platinum, 18: 34029(R) (AD-601740)
Nb–Ta–W–Zr, welding of FS-85, electron-beam and tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Nb–Ti–Zr, properties of D-36 foils at high temperatures, effects of coatings on mechanical and thermophysical, 18: 34128 (RTD-TDR-63-4068)
Nb–U–Zr, reactions of molybdenum with uranium in, 18: 34174
Nb–W–Zr, fabrication and properties of Cb-752 sheet, 18: 34025(R) (AD-428036)
Nb–W–Zr, welding of Cb-752 and D-43, tungsten-arc, 18: 34058(R) (WANL-PR(P)-003)
Nb–Zr, coating of D-14 for oxidation protection, 18: 34052 (RTD-TDR-63-4063)
Nb–Zr, current-carrying capacity of superconducting, temperature and field dependence of, 18: 34681 (BSD-TDR-64-87)
Nb–Zr, embrittlement effects of hydrogen on, 18: 34169
Nb–Zr, magnetic flux jumps in superconducting, 18: 34724
Nb–Zr, properties for use as superconductive wires, 18: 34200
Nb–Zr, superconducting magnets of, 18: 34715
Ni–Zr, corrosion by steam at 400°C, hydrogen sorption during, 18: 34060(T,R) (EURAEC-1062)
Ni–Zr, embrittlement effects of hydrogen on, 18: 34169
Sn–V–Zr, corrosion by steam at 350, 400, and 480°C, hydrogen sorption during, 18: 34060(T,R) (EURAEC-1062)
Sn–V–Zr, fabrication and mechanical properties, effects of heat treatments on, 18: 34060(T,R) (EURAEC-1062)
Ti–Zr, creep activation in, limiting values for, 18: 34152
Ti–Zr, magnetic moments and superconductivity of, 18: 34700
U–Zr, annealing irradiated, 18: 34234
U–Zr, properties as reactor fuel, 18: 34130 (TID-8540(p.331-410))
U–Zr, structure of, effects of cooling rate from gamma phase on, 18: 34127 (RT/MET(64)-2)

ZIRCONIUM ARSENATES
ion exchange properties of, effects of acids and hydrolysis on, 18: 33535

ZIRCONIUM FLUORIDES
preparation properties, and structure of divalent, 18: 33544
BeF_2–LiF–ThF_4–UF_4–ZrF_4, radiation effects on, 18: 34050(R) (ORNL-3626(p.59-164))
BeF_2–LiF–ZrF_4, crystallographic and phase studies on, 18: 34050(R) (ORNL-3626(p.59-164))
LiF–NaF–ZrF_4, corrosive effects on HyMu-80 and INOR-8 under hydrofluorination conditions, 18: 34034(R) (BMI-1672(Del.))

ZIRCONIUM HYDRIDES
preparation, 18: 35247(R) (NAA-SR-9700)
U–ZrH, fission product release from irradiated SNAP 10A/2 fuel, 18: 34045 (NAA-SR-9673)

ZIRCONIUM ISOTOPES
separation in calutrons, 18: 34007(R) (ORNL-TM-890)

ZIRCONIUM ISOTOPES Zr-90
gamma emission in 0^+–0^+ transitions in, double, 18: 34752(R) (CU(PNPL)-234)
nuclear structure of, alpha cluster reduced widths for, 18: 34891

ZIRCONIUM ISOTOPES Zr-95
content in fallout in French Territory, 18: 33770 (SCPRI(S)-99)
determination in liquids, gamma spectrometric, 18: 33485
determination in urine and feces of, gamma spectrometric, 18: 33264
gamma spectra of, least-squares analysis of, 18: 33926
separation from niobium-95 by ion exchange on pyrocatechol-*O,O*-diacetic acid, 18: 33508
sorption by river silts, 18: 35238 (STI/DOC/10/28(p.9-20))

ZIRCONIUM OXIDES
analysis for sulfur, luminescent method for, 18: 33513
catalytic effects on radioinduced polymerization of solid 3,3-*bis*-chloromethyloxatane, 18: 33651
electrochemistry of passivating films of, formed on metal by polarization, 18: 34063
properties and sinterability at high temperatures, effects of aluminum, calcium, magnesium, and titanium oxides on, 18: 34155

ZIRCONIUM PHOSPHATES
ion exchange properties of, effects of acids and hydrolysis on, 18: 33535
precipitation and/or uptake of uranyl ion by, in hydrochloric acid, 18: 33600

ZIRCONIUM SYSTEMS

Al–C–Mo–Ni–Si–U–Zr, preparation and fabrication as refractory fuel material, 18: 34071(P)
C–Nb–Zr, phase studies on, 18: 34211
Nb–O–Zr, phase studies on, 18: 34211
O–Zr, electron energy bands in crystals of, 18: 33543

ZIRCONIUM TUNGSTATES
ion exchange properties of, effects of acids and hydrolysis on, 18: 33535
ZIRCONS
lead/uranium ratios in Panamint Range, 18: 33793

REPORT NUMBER INDEX

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7	18-34501	ORINS. Gmelin, AED-CONF-64-036-7
CONF-543–	**(American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964)**	
5	18-35045	ORINS. Gmelin, AED-CONF-64-028-7
7	18-34248	ORINS. Gmelin, AED-CONF-64-028-18
8	18-34724	ORINS. Gmelin, AED-CONF-64-028-15
CONF-549–	**(International Symposium on Oxidases and Related Oxidation-Reduction Systems, Amherst, Mass., July 1964)**	
3	18-33521	See BNL-8081
CONF-550–	**(The International Conference on High-Energy Physics, Dubna, Aug. 1964)**	
3	18-34514	See UCRL-11430
4	18-34515	See UCRL-11431
5	18-34517	See UCRL-11436
6	18-34513	See UCRL-11428
7	18-34518	See UCRL-11546
8	18-34519	See UCRL-11549
CONF-553–	**(American Ceramic Society 66th Annual Meeting Including Symposium on Nuclear and Space Applications, Chicago, Apr. 1964)**	
2	18-34212	ORINS. Gmelin, AED-CONF-64-048-9
7	18-34120	See CNLM-5621
8	18-33523	See CNLM-5619
9	18-33524	See CNLM-5620
CONF-554–	**(Cryogenic Engineering Conference, Philadelphia, Aug. 1964)**	
2	18-33804	See LADC-6432
CONF-561–	**(Symposium on Inhaled Radioactive Particles and Gases,**	

Report No.	Abstract No.	Availability
	Richland, Wash., May 1964)	
2	18-33823	ORINS. Gmelin, AED-CONF-64-049-3
CONF-571–	**(American Chemical Society 148th National Meeting, Chicago, Aug.–Sept. 1964)**	
3	18-33682	See ORNL-P-200
4	18-33612	See BNL-8066
CONF-593–	**(Conference on the Automatic Acquisition and Reduction of Nuclear Data, Karlsruhe, Ger., July 1964)**	
2	18-34366	See BNL-8166
3	18-33876	See BNL-8180
CONF-599–	**(3rd International Congress of Polarography, Southampton, England, July 1964)**	
3	18-33452	See ORNL-P-145
CONF-600–	**(American Institute of Aeronautics and Astronautics, 1st. Annual Meeting, Washington, D. C., June–July 1964)**	
1	18-33698	ORINS
2	18-35216	ORINS
3	18-33699	ORINS
5	18-33751	ORINS
7	18-34001	ORINS
8	18-35210	ORINS
9	18-33700	ORINS
12	18-33701	ORINS
16	18-35040	ORINS
17	18-33702	ORINS
19	18-34247	ORINS
20	18-34256	ORINS
21	18-33703	ORINS
22	18-33704	ORINS
23	18-33705	ORINS
24	18-33706	ORINS
26	18-35211	ORINS
27	18-35212	ORINS
28	18-34002	ORINS
29	18-33719	ORINS
30	18-33720	ORINS
31	18-34363	ORINS
32	18-35213	ORINS
33	18-33707	ORINS
34	18-35214	ORINS
35	18-34003	ORINS
36	18-34457	ORINS
38	18-35041	ORINS
39	18-35042	ORINS
CONF-603–	**(Transaction of Meeting, Vacuum Metallurgy, American Vacuum Society, New York, June–July 1964)**	
5	18-34057	See UCRL-11411
CONF-609–	**(AIAA General Aviation Aircraft Design and Operations Meeting, Wichita, Kan., May 1964)**	
1	18-35215	ORINS
CONF-610–	**(Society of Automotive Engineers, Inc., Summer Meeting, Chicago, June 1964)**	
1	18-34503	ORINS
2	18-33721	ORINS
CONF-619–	**(18th Meeting of the AEC Metallography Group, Los Angeles, June 1964)**	
1	18-34047	See NLCO-910
CONF-620–	**(Institute of Nuclear Materials Management 5th Annual Meeting, Pittsburgh, May 1964)**	
2	18-33799	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-64-056-3
CONF-621–	**(IAEA Panel on In-Pile Dosimetry, Vienna, July 1964)**	
1	18-33879	See HW-SA-3585
CONF-623–	**(American Medical Association Congress on Environmental Health Problems, Chicago, May 1964)**	
1	18-33430	ORINS. Gmelin, AED-CONF-64-043-2
2	18-33401	ORINS. Gmelin, AED-CONF-64-043-1
CONF-625–	**(American Meteorological Society 228th National Meeting, Washington, D. C., Apr. 1964)**	
1	18-34257	ORINS. Gmelin, AED-CONF-64-045-1
CONF-628–	**(20th Annual Powder Metallurgy Technical Conference, Chicago, Apr. 1964)**	
1	18-34113	ORINS. Gmelin, AED-CONF-64-059-2
CONF-632–	**(Lecture at Post-ICO-Meeting Seminar on Lens Design, Tokyo, Sept. 1964)**	
1	18-35245	See LADC-6205
CONF-633–	**(Electromagnetic Window Symposium, Columbus, Ohio, June 1964)**	
1	18-34054	See UCRL-7795
CONF-634–	**(American Ordnance Association Propellants and Explosive Section Meeting, Wright-Patterson AFB, Ohio, Sept. 1964)**	
1	18-35252	See UCRL-7898
CONF-635–	**(AEC Atomic Industrial Forum, Washington, D. C., May 1964)**	
1	18-33983	See HW-SA-3080(Rev.)
CONF-638–	**(National Physical Laboratory Conference on Thermal Conductivity, Teddington, England, July 1964)**	
4	18-33833	See ORNL-TM-883
COO–		
7-331	18-34917	Phys. Rev., 135: A1429-36(1964)
535-523	18-34934	Rev. Sci. Instr., 35: 1197-1200(1964)
1195-06	18-34564	Phys. Rev., 135: B1005-9(1964)
1277-5	18-34404	Dep.(mc); $1.10(fs), $0.80(mf) OTS
CR–	**(Misc.)**	
71	18-34382	See NP-14141
CU(PNPL)–		
234	18-34752	Dep.(mc); $13.00(fs), $5.63(mf) OTS
CVNA–	**(Misc.)**	
207	18-35140	Dep.(mc); $8.10(fs), $2.69(mf) OTS
208	18-35141	Dep.(mc); $2.60(fs), $0.92(mf) OTS
D–	**(Misc.)**	
1-82-0331	18-34267	$2.60(OTS)
DLCS–		
5000564	18-35142	Dep.(mc); $3.60(fs), $1.13(mf) OTS
DMIC-Memo–	**(Non-AEC)**	
189	18-34121	OTS
192	18-34037	OTS
DP–		
879	18-33461	Dep.; $0.50(OTS)
883	18-33462	Dep.; $0.50(OTS)
893	18-33877	Dep.; $0.50(OTS)
897	18-33826	Dep.; $0.50(OTS)
915	18-35143	Dep.; $1.25(OTS)
DPST–		
64-83-6	18-35061	Dep.(mc); $1.10(fs), $0.80(mf) OTS
DTMB–	**(Non-AEC)**	
1814	18-34728	
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
E–	**(Misc.)**	
2439	18-34074	See IDO-24460
EANDC(E)–	**(European-American Nuclear Data Committee)**	
50(L)	18-34753	Dep.(mc)
EFINS–	**(Misc.)**	
64-13	18-34632	See CONF-452-35

Report No.	Abstract No.	Availability
EGCR-STUDY–		
II-601	18-35163	See TID-20890
II-601-1	18-35164	See TID-20891
EUR–	**(European Atomic Energy Community)**	
1821.f	18-33800	Dep.(mc)
1823.d	18-33827	Dep.(mc)
1833.e	18-34038	Dep.(mc)
EURAEC–		
795	18-34035	See BMI-X-10053
915	18-34089	Dep.(mc); $14.50(fs), $6.62(mf) OTS
992	18-35130	Dep.(mc); $1.10(fs), $0.80(mf) OTS
1015	18-34090	Dep.(mc); $2.60(fs), $1.07(mf) OTS
1062	18-34060	Dep.(mc); $2.60(fs), $1.01(mf) OTS
1086	18-33732	Dep.(mc); $5.60(fs), $1.82(mf) OTS
1126	18-34214	Dep.(mc); $5.60(fs), $1.97(mf) OTS
1127	18-33733	Dep.(mc); $1.60(fs), $0.80(mf) OTS
1131	18-33693	See ACNP-64026
1134	18-35147	See GEAP-4645
1137	18-33729	See ACNP-64027
1138	18-35062	Dep.(mc); $10.10(fs), $3.83(mf) OTS
1140	18-35127	See GEAP-3771-13
1141	18-33734	See GEAP-4646
1142	18-34215	See GEAP-4624
1144	18-35126	See CEND-3107-216
1149	18-35128	See GEAP-4642
FTD-TT–	**(Non-AEC)**	
63-814	18-33474	OTS
64-350	18-34061	OTS
GA–	**(Misc.)**	
4850	18-34739	Nucl. Sci. Eng., 19: 412-17(1964)
4900	18-34122	Dep.(mc); $6.60(fs), $2.15(mf) OTS
5340	18-34039	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5404	18-34495	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GEAP–	**(Misc.)**	
3771-13	18-35127	Dep.(mc); $6.60(fs), $2.18(mf) OTS
4435	18-34086	Dep.(mc); $4.60(fs), $1.70(mf) OTS
4438	18-34073	Dep.(mc); $14.00(fs), $6.32(mf) OTS
4560	18-35144	Dep.(mc); $8.60(fs), $3.20(mf) OTS
4566	18-35145	Dep.(mc); $9.10(fs), $3.26(mf) OTS
4601	18-35146	Dep.(mc); $8.60(fs), $3.02(mf) OTS
4624	18-34215	Dep.(mc); $3.60(fs), $1.34(mf) OTS
4642	18-35128	Dep.(mc); $1.60(fs), $0.80(mf) OTS
4645	18-35147	Dep.(mc); $1.60(fs), $0.80(mf) OTS
4646	18-33734	Dep.(mc); $2.60(fs), $0.92(mf) OTS
GEMP–	**(Misc.)**	
36A	18-34040	Dep.; $1.00(OTS)
HMI-B–	**(German)**	
35	18-34754	Dep.(mc)
HNS–		
1229-47	18-33766	Dep.(mc); $7.60(fs), $2.54(mf) OTS
HR–	**(Non-AEC)**	
64-269	18-34123	
HW–		
53440	18-33712	$1.10(fs), $0.80(mf) OTS
74663	18-33525	$1.60(fs), $0.83(mf) OTS
76850	18-33694	Dep.(mc); $1.60(fs), $0.80(mf) OTS
78431	18-35193	Dep.(mc); $1.10(fs), $0.80(mf) OTS
78964	18-35194	Dep.(mc); $1.10(fs), $0.80(mf) OTS
79676	18-34124	Dep.; $1.00(OTS)
80204	18-33801	Dep.(mc); $2.60(fs), $1.07(mf) OTS
80216	18-33802	Dep.(mc); $1.60(fs), $0.80(mf) OTS
80291	18-35129	Dep.; $0.50(OTS)
80752	18-34041	Dep.; $1.75(OTS)
81117(Rev.1)	18-34015	Dep.(mc); $1.10(fs), $0.80(mf) OTS
81211	18-35111	$1.10(fs), $0.80(mf) OTS
81774	18-33878	Dep.; $0.50(OTS)
81862	18-35234	Dep.; $1.00(OTS)
82233	18-35195	Dep.(mc); $1.60(fs), $0.80(mf) OTS
HW-SA–		
2966	18-34231	Nucl. Sci. Eng., 19: 390-2(1964)
3080(Rev.)	18-33983	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3585	18-33879	Dep.(mc); $1.10(fs), $0.80(mf) OTS
HW-tr–		
78	18-33809	Dep.(mc); $1.60(fs), $0.80(mf) JCL
I–	**(Misc.)**	
A2392-4	18-35150	See NYO-9789
IA–	**(Non-AEC)**	
891	18-35148	Dep.(mc)
892	18-35218	Dep.(mc)
893	18-33447	Dep.(mc)
894	18-35219	Dep.(mc)
924	18-33526	Dep.(mc)
IDO–		
12036	18-35235	Dep.(mc); $2.60(fs), $0.92(mf) OTS
14644	18-33448	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16880-1	18-34755	Dep.; $10.00(OTS)
16880-2	18-34756	Dep.; $10.00(OTS)
16883	18-35220	Dep.; $2.75(OTS)
16968	18-34729	Dep.; $2.00(OTS)
24460	18-34074	Dep.(mc); $13.50(fs), $6.11(mf) OTS
IFA–	**(Rumanian)**	
28-IS	18-33527	Dep.(mc)
IFA-IS–	**(Rumanian)**	
27	18-34268	Dep.(mc)
IG-Report–	**(British)**	
52	18-35063	Dep.(mc); $0.90(BIS); 4s. 6d. (HMSO)
IITRI–	**(Misc.)**	
1184-13	18-35243	Dep.(mc); $3.60(fs), $1.13(mf) OTS
INR-NR–	**(German)**	
59/63	18-35114	For translation see ORNL-tr-263
INSJ–	**(Japanese)**	
72	18-34757	Dep.(mc)
IS–		
666	18-34165	J. Less-Common Metals, 7: 67-83(1964)
685	18-34454	p.181-220 of "Phonons and Phonon Interactions." New York, W. A. Benjamin, Inc., 1964
856	18-34576	Phys. Rev., 135: B1085-6(1964)
877	18-33656	Phys. Rev., 135: A1218-19(1964)
JEN–	**(Spanish)**	
122-DF/I-38	18-34016	Dep.(mc)
130-DF/I-41	18-34758	Dep.(mc)
136-DQ/I-40	18-33679	Dep.(mc)
137-DQ/I-41	18-33680	Dep.(mc)
138-DQ/I-42	18-33681	Dep.(mc)
139-DQ/I-43	18-33463	Dep.(mc)
JINR–	**(Russian)**	
D-1693	18-34759	Dep.(mc)
E-1686	18-34507	Dep.(mc)
E-1696	18-34760	Dep.(mc)
E-1703	18-34761	Dep.(mc)
P-1671	18-34762	Dep.(mc)
P-1674	18-34508	Dep.(mc)
P-1675	18-34763	Dep.(mc)
P-1678	18-34764	Dep.(mc)
P-1679	18-34765	Dep.(mc)
P-1681	18-34369	Dep.(mc)
P-1682	18-34269	Dep.(mc)
P-1687	18-34766	Dep.(mc)
P-1706	18-34767	Dep.(mc)
JPRS–		
25467	18-35091	$0.75(OTS)
25502	18-33285	$0.50(OTS)
25692	18-34373	$1.00(OTS)

Report No.	Abstract No.	Availability
KAPL-M-		
6165	18-35244	Dep.(mc); $1.60(fs), $0.80(mf) OTS
KFK-	**(German)**	
208	18-33629	Chem. Ing. Tech., 36: 15-23(1964)
220	18-34125	Dep.(mc)
KR-	**(Norwegian)**	
77	18-34730	Dep.(mc)
LA-		
3094	18-33803	Dep.; $0.50(OTS)
LADC-		
6118	18-34384	Astrophys. J., 139: 775-6(1964)
6162	18-34740	Nucl. Sci. Eng., 19: 431-6(1964)
6163	18-34437	Phys. Rev., 135: A969-73(1964)
6167	18-34331	Phys. Fluids, 7: 1388-90(1964)
6196	18-34531	J. Math. Phys. (N. Y.), 5: 1053-4(1964)
6205	18-35245	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6212	18-33553	J. Chem. Phys., 40: 3584-5(1964)
6237	18-34332	Phys. Fluids, 7: 1390-1(1964)
6299	18-33748	Phys. Fluids, 7: 1147-56(1964)
6314	18-34559	Phys. Rev., 135: A922-31(1964)
6423	18-33572	J. Chem. Phys., 41: 1515-16(1964)
6432	18-33804	Dep.(mc); $1.60(fs), $0.80(mf) OTS
LAL-	**(French)**	
1093	18-34270	Dep.(mc)
1107	18-34271	Dep.(mc)
1110	18-34370	Dep.(mc)
MAB-	**(Non-AEC)**	
199-M(1)	18-34042	
MATT-		
241	18-35017	Phys. Today, 17: 19-26(1964)
MIT-	**(Misc.)**	
2079-2	18-33735	Dep.(mc); $10.10(fs), $3.83(mf) OTS
2098-61	18-34768	Dep.(mc); $1.10(fs), $0.80(mf) OTS
MITNE-	**(Misc.)**	
48	18-33619	Dep.(mc); $10.50(fs), $4.37(mf) OTS
ML-TDR-	**(Non-AEC)**	
64-173(Pt.I)	18-34043	
MLM-		
1196	18-35246	Dep.; $0.50(OTS)
MT-	**(Misc.)**	
63-10	18-34284	See UCRL-13088
N-	**(Misc.)**	
6022	18-35203	See NP-14139
64-16014	18-34213	See AI-64-11
64-22244	18-34046	See NASA-CR-54041
64-24054	18-33828	See NASA-CR-54059
64-25918	18-34497	See NP-12888(Vol.5)
NAA-SR-		
8617(Vol.I)	18-35198	Dep.; $2.75(OTS)
9054	18-35199	Dep.; $2.50(OTS)
9280	18-35200	Dep.; $2.25(OTS)
9368	18-35201	Dep.; $1.00(OTS)
9509	18-35149	Dep.; $0.50(OTS)
9600	18-34044	Dep.; $0.50(OTS)
9655	18-35202	Dep.; $2.00(OTS)
9673	18-34045	Dep.; $0.75(OTS)
9700	18-35247	Dep.; $3.00(OTS)
NAMC-AML-	**(Non-AEC)**	
1550	18-34126	
NASA-CR-	**(Misc.)**	
87	18-34405	$1.00(OTS)
88	18-34272	$2.00(OTS)
52997	18-33464	Dep.(mc); $4.60(fs), $1.64(mf) OTS
54041	18-34046	
54059	18-33828	$2.60(OTS)
54071	18-34075	
54088	18-34058	See WANL-PR(P)-003
54105	18-34059	See WANL-PR(Q)-003
54110	18-34731	
55760	18-34213	See AI-64-11
55800	18-34497	See NP-12888(Vol.5)
NASA-TN-	**(Misc.)**	
D-2299	18-33736	$0.75(OTS)
D-2348	18-33695	$0.50(OTS)
D-2364	18-34216	$0.50(OTS)
D-2400	18-34273	$1.25(OTS)
D-2401	18-33696	$1.00(OTS)
NASA-TT-	**(Non-AEC)**	
F-126	18-34461	$4.00(OTS)
F-229	18-34383	$1.75(OTS)
NBS-	**(Misc.)**	
8407	18-34682	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NDL-SP-	**(Non-AEC)**	
6	18-33880	
NIRS-	**(Japanese)**	
2	18-35248	Dep.(mc)
NLCO-		
910	18-34047	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NOLTR-	**(Non-AEC)**	
63-134	18-33829	OTS
NORA-	**(Norwegian)**	
12	18-34730	See KR-77
NP-	**(AEC File No. for Non-AEC Reports)**	
12888(Vol.5)	18-34497	OTS
13986	18-34371	Dep.(mc)
14076	18-34637	Dep.(mc)
14080	18-33528	Dep.(mc)
14085	18-34769	Dep.(mc)
14086	18-34509	Dep.(mc)
14091	18-33769	Dep.(mc)
14114	18-34275	Dep.(mc)
14115	18-34770	Dep.(mc)
14124	18-34048	
14129	18-34276	Dep.(mc)
14131	18-33881	Dep.(mc)
14134	18-34277	
14136	18-34683	
14139	18-35203	
14141	18-34382	
14145	18-33780	
14146	18-34510	
14153	18-34974	Dep.(mc)
14174(Vol.1)	18-34278	Dep.(mc)
14175	18-34771	Dep.(mc)
14176	18-33794	Dep.(mc)
14183	18-34217	
14184	18-34772	Dep.(mc)
14186	18-34279	
14187	18-33620	Dep.(mc)
14190	18-34773	
14194	18-34975	
14195	18-34976	
NP-tr-	**(AEC File No. for Non-AEC Translations)**	
1160	18-34287	Dep.(mc); $1.60(fs), $0.80(mf) JCL
NPCC-FEWP-	**(British)**	
P.691	18-35063	See IG-Report-52
NRC-	**(Canadian)**	
7847	18-33897	Can. Geotech. J., 1: 94-103(1964)
7960	18-34802	Can. J. Phys., 42: 1387-1410(1964)
NUMEC-P-		
106	18-34049	Dep.(mc); $4.60(fs), $1.58(mf) OTS

Report No.	Abstract No.	Availability
NYO–		
910-1	18-33274	Dep.(mc); $1.10(fs), $0.80(mf) OTS
910-2	18-33275	Dep.(mc); $1.60(fs), $0.80(mf) OTS
910-3	18-33232	Dep.(mc); $2.60(fs), $0.86(mf) OTS
910-7	18-33276	Dep.(mc); $1.10(fs), $0.80(mf) OTS
910-9	18-33233	Dep.(mc); $1.10(fs), $0.80(mf) OTS
1957-37	18-33640	J. Chem. Phys., 40: 3730-1(1964)
2570-1	18-33212	Dep.(mc); $4.60(fs), $1.70(mf) OTS
2584-1	18-34511	Dep.(mc); $1.10(fs), $0.80(mf) OTS
2680-1	18-34280	Dep.(mc); $3.60(fs), $1.22(mf) OTS
2757-4	18-33450	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3190-1	18-33882	Dep.(mc); $5.60(fs), $1.76(mf) OTS
9789	18-35150	Dep.(mc); $22.25(mf); $13.40(mf) OTS
10556	18-33830	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10558	18-33831	Dep.(mc); $1.10(fs), $0.80(mf) OTS
10560	18-33832	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10715	18-33806	Dep.(mc); $1.10(fs), $0.80(mf) OTS
ORNL–		
3334(Pt.II)	18-33529	Dep.; $0.75(OTS)
3612	18-35236	Dep.; $1.50(OTS)
3626	18-35064	Dep.; $2.75(OTS)
3629	18-35237	Dep.; $0.50(OTS)
3644	18-34087	Dep.; $1.50(OTS)
3645	18-34088	Dep.; $1.75(OTS)
3654	18-33451	Dep.; $0.50(OTS)
ORNL-P–		
18	18-33737	Dep.(mc); $1.60(fs), $0.80(mf) OTS
40	18-33655	Nucleonics, 22: 104-5(1964)
89	18-35014	Phys. Rev. Letters, 13: 179-81(1964)
144	18-34774	Dep.(mc); $8.10(fs), $2.72(mf) OTS
145	18-33452	Dep.(mc); $9.60(fs), $3.71(mf) OTS
200	18-33682	Dep.(mc); $3.60(fs), $1.37(mf) OTS
ORNL-TM–		
564	18-35151	Dep.(mc); $2.60(fs), $0.98(mf) OTS
632	18-35222	Dep.(mc); $2.60(fs), $1.01(mf) OTS
732	18-35152	Dep.(mc); $14.50(fs), $6.62(mf) OTS
749	18-34051	Dep.(mc); $1.60(fs), $0.80(mf) OTS
829	18-33530	Dep.(mc); $2.60(fs), $1.01(mf) OTS
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963,955	18-35094	
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964,017	18-33870	
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965,536	18-35099	
965,692	18-33608	
965,693	18-33609	
965,710	18-34070	
965,751	18-33725	
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